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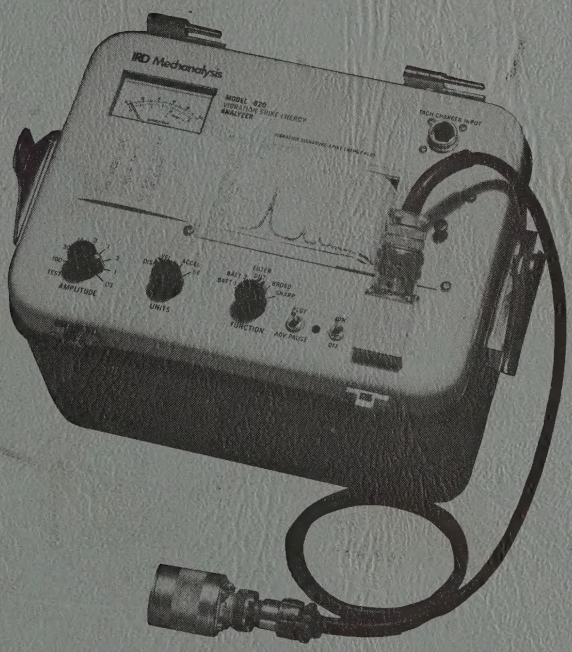

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OPERATOR MANUAL FOR VIBRATION/SPIKE ENERGY ANALYZER MODEL 820/820M

IRD MECHANALYSIS OPERATOR MANUAL FOR VIBRATION/SPIKE ENERGY ANALYZER MODEL 820/820M

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6150 Huntley Road
Columbus, Ohio 43229
614–885-5376
Telex 24-5318

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I INTRODUCTION

The Model 820 Vibration/SPIKE ENERGY Analyzer is a lightweight, portable battery operated vibration signature check instrument. A hard copy printer is built into the instrument, and is capable of generating a complete vibration spectrum from 600 to 600,000 CPM (10 Hz to 10,000 Hz) in 44 seconds. The Model 820 is fully microprocessor controlled and automatically records the settings of all selector switches to give an error-free, fully annotated printout of a vibration spectrum including: the correct engineering units, the filter bandwidth setting, and the amplitude and frequency scale values as well. With the optional tachometer unit, the instrument also prints out the machine RPM.

In addition to performing signature analysis, the Model 820 is capable of two other modes of operation. The first of these is the capability to plot overall amplitude vs. time. This function can be extremely valuable during machine startup and coastdown to identify criticals, natural frequencies, resonances and beats. The second capability, plotting SPIKE ENERGY amplitude vs. time, provides a hard copy record of the mechanical condition of rolling element bearings and gears. The special SPIKE ENERGY circuits detect ultrasonic energy bursts caused by microscopic defects in bearings and gears, and provides the operator with advanced warning of deterioration in these machine components.

Other features include an accessory storage rack in the cover, and a built-in rechargeable sealed lead acid battery pack. The battery pack can be replaced in about one minute with a fresh unit to enable the Model 820 to be operated 24 hours a day without taking it out of service for recharging. A separate battery charger is used to recharge the built-in battery pack, as well as extra battery packs.

The Model 820 has been designed to fill the need in many vibration predictive maintenance programs which call for a unit which has more capability than the small hand-held portable vibration meters, but less than the full capability of the powerful vibration analyzers/dynamic balancers.

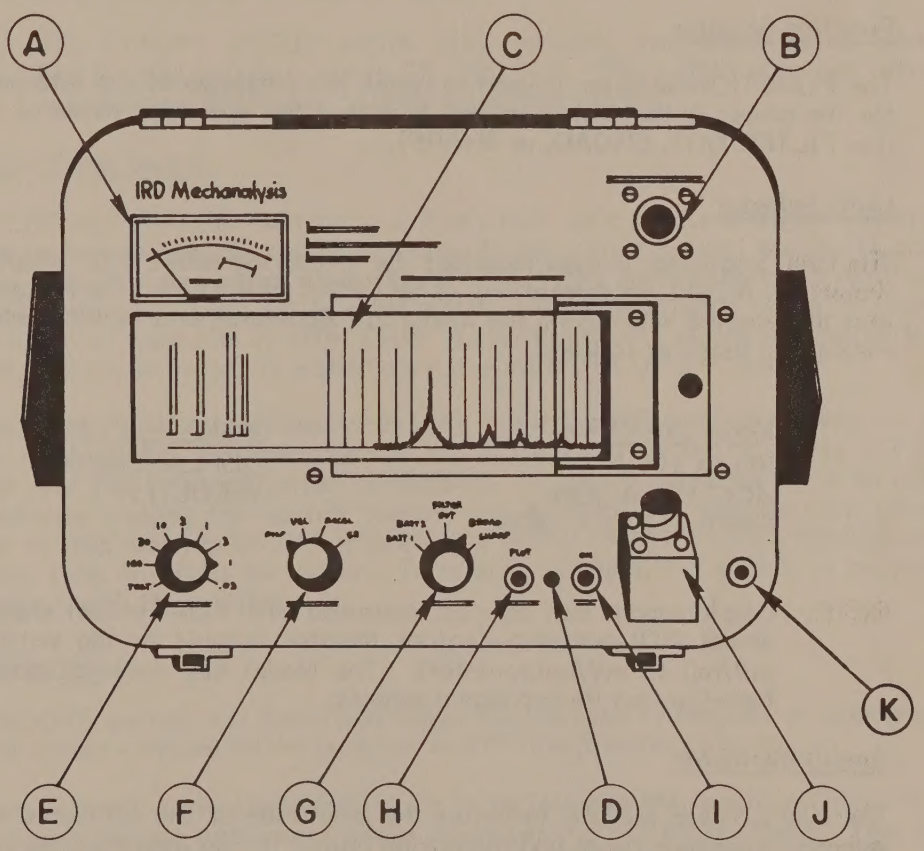
In this respect, perhaps the most important feature of the Model 820 is the ease, accuracy and speed with which it can be used. It is small and completely self-contained. There are no cables to connect, since the pickup and its cable can remain connected to the unit. The operator simply carries the unit to the machine, attaches the pickup to the machine, toggles the power and plot switches, and in 44 seconds a complete narrow band vibration signature over the full range of the instrument is produced. Even the annotation is performed automatically, so that the operator never needs to write down the amplitude scales or engineering units.

The Model 820 is an excellent unit for predictive maintenance programs in which periodic signature checks are desirable for critical machines. These signature checks, rather than overall (i.e., Filter Out) checks, enable a closer watch to be maintained and a more advanced warning given of any changes in the mechanical condition of such a machine. The Model 820 is also useful for establishing "baseline" signatures, or for post-repair checks to verify that a machine has been returned to its proper operating condition.

II DESCRIPTION

2.1 DESCRIPTION OF CONTROLS AND INDICATORS

This section describes the various controls, indicators and the printer/plotter of the Model 820. The specifications of the 820 instrument are listed in Appendix A. The instrument front panel is shown below in Figure 2-1.



A. AMPLITUDE METER
B. TACH/CHARGER INPUT RECEPTACLE
C. PRINTER/PLOTTER
D. SELF-CHECK LIGHT
E. AMPLITUDE SELECTOR
F. UNITS SELECTOR
G. FUNCTION SELECTOR
H. PLOT ADV/PAUSE SWITCH
I. ON-OFF SWITCH
J. PICKUP SIGNAL INPUT RECEPTACLE
K. LID ACTUATED ON-OFF SWITCH

FIGURE 2-1 MODEL 820 FRONT PANEL

Amplitude Selector

The AMPLITUDE selector is used to select the full-scale amplitude range, or the TEST mode. Eight full-scale, overlapped ranges are provided. In English units, the ranges are provided from 0.03 to 100 mils, peak to peak, inches/second, peak, or g's, peak. In Metric units, the ranges are provided from 1.0 to 3000 micrometers, peak to peak, 1.0 to 3000 mm/second, peak, or 0.03 to 100 g's, peak.

The TEST position is used to check the operation of the instrument circuits. In this position, an indication in the range of 0.75 to 0.85 on the upper scale of the AMPLITUDE METER signifies that all instrument circuits are operating correctly. This TEST function does not apply to the SE units mode.

Function Selector

The FUNCTION selector is used to check the batteries of the internal battery pack for the proper output voltages, and to select the operating mode of the instrument (i.e. FILTER OUT, BROAD, or SHARP).

Units Selector

The UNITS selector is used to select the measuring units: DISP (displacement), VEL (velocity), ACCEL (acceleration), or SE (SPIKE ENERGY). The measuring units that may be selected when using the Model 970 Accelerometer or the Model 544 Velocity Pickup are listed as follows:

Model 970 Pickup	Model 544 Pickup
VELOCITY	DISPLACEMENT
ACCELERATION	VELOCITY
SPIKE ENERGY Units	

NOTE: Displacement can also be measured with Non-Contact signal sensors (e.g. Model 403) and Non-Contact Monitor outputs having sensitivities of 200 mV/mil (8 mV/micrometer). The Model 820 does not provide power for Non-Contact Pickup signal sensors.

Amplitude Meter

The AMPLITUDE METER indicates the amplitude of the unfiltered vibration in the selected amplitude range and measuring units. It also indicates the condition of the internal batteries in the BATT 1 and BATT 2 modes. In addition, in the TEST mode, the meter also indicates whether or not the analyzer circuits are functioning properly.

Printer/Plotter

The PRINTER/PLOTTER is an alphanumeric-graphic unit located inside the instrument case. The drive system and paper roll are accessible when the small cover panel is removed from the front panel of the instrument. The Printer/Plotter is used to obtain plots of: vibration amplitude vs. time, vibration signatures, test signal spectrum, and SPIKE ENERGY units vs. time.

Printer/Plotter Chart Speed Switch

This toggle switch is located under the Printer/Plotter cover, and controls the speed of the chart paper when the FUNCTION selector is set to FILTER OUT. The switch provides for 3 chart speeds and printing rates as follows:

Mode	Paper Speed	Rate (Points/Sec)
Slow	.65 in. (1.7 cm) per min.	0.5
Medium	3.25 in. (8.3 cm) per min.	2.5
Fast	13 in. (33 cm) per min.	10.0

NOTE: The CHART SPEED switch only controls the chart speed when the FUNCTION switch is set to FILTER OUT. The switch does not affect the speed in the BROAD or SHARP frequency modes.

Plot-Adv/Pause Switch

The PLOT-ADV/PAUSE switch is a 3-position spring-return toggle switch. To initiate a plot, the toggle switch is momentarily pushed toward the PLOT position. Pushing once initiates a plot from 600 to 600K CPM; pushing twice in rapid succession initiates a plot from 6K to 600K CPM; and pushing three times in succession initiates a plot from 60K to 600K CPM. To terminate the plot after the plotting has started, the toggle switch is pushed once toward the PLOT position.

The paper may be run out (advanced) from the Printer/Plotter by holding the switch in the ADV/PAUSE position anytime the FUNCTION switch is set to BROAD or SHARP and the Printer/Plotter is stopped. If the Printer/Plotter is functioning, momentarily pushing the switch toward the ADV/PAUSE position will cause the printer to stop plotting (pause). Pushing the switch toward the ADV/PAUSE position a second time advances the paper. To resume plotting, the switch is momentarily pushed to the PLOT position.

On-Off Switch

The ON-OFF switch is a 2-position toggle switch used to connect or disconnect the battery supply voltages to the analyzer and Printer/Plotter circuits.

A second switch, connected electrically in series with the toggle switch, automatically disengages the instrument power whenever the 820 lid is closed. This feature prevents the power from being left on when the unit is not in use.

Self Check Light

This red LED turns on when the ON/OFF switch is initially set to ON, and indicates that the automatic check cycle of the microprocessor circuits is in process. This light automatically turns off after approximately 6 seconds if the instrument circuits are functioning correctly.

After the turn-on check is completed, the red LED will start to blink at approximately 2 second intervals to alert the operator that the power is on. This blinking light is a reminder to turn off the unit when measurements are finished.

2.2 DESCRIPTION OF CABLE RECEPTACLES

Pickup Signal Input Receptacle

The PICKUP SIGNAL INPUT RECEPTACLE is located on the front panel of the instrument, and consists of a twist-lock female receptacle for connection of signal input cables from the Model 970 Accelerometer, the Model 544 Velocity Pickup, Non-Contact signal sensors, or Non-Contact monitors.

Tach/Charger Input Receptacle

The TACH/CHARGER INPUT RECEPTACLE consists of a threaded female receptacle, and is located on the front panel of the instrument. This receptacle receives the threaded connector from the Model 426 Battery Charger when the internal batteries are being recharged. Both batteries must have sufficient charge to indicate in the "LO-BATTERY-HI" test area in order for the unit to be operated. Batteries MUST BE INSTALLED before connecting the Model 426 Battery Charger.

This receptacle also receives the connection from the optional tachometer input cables for the photocell, or the electromagnetic, reference pickup.

2.3 DESCRIPTION OF POWER FUSES AND BATTERY PACK

Power Fuses

Two POWER FUSES are provided in the analyzer, and are located inside the instrument case. Both fuses are accessible through the Battery Pack compartment when the cover panel and Battery Pack are removed. The fuses are located on the small PC Board at the right-hand side of the battery compartment. The 1-1/2 ampere fuse (Part No. 01508) protects the Analyzer circuits from the 6-volt battery pack output voltage, and the 2-ampere fuse (Part No. 20138) protects the Printer/Plotter circuits from 12-volt battery pack output voltages. The location of these fuses is shown in Figure 2-2.

Battery Pack

The BATTERY PACK (Part No. 24400) contains three sealed lead acid rechargeable batteries which supply voltage to the Analyzer and Printer/Plotter circuits. The Battery Pack is located in the battery compartment inside the instrument case, and can be readily replaced in the field by removal of the cover panel on the front side of the case. The battery pack is shown in Figure 2-3. The temperature requirements for the operation and storage of the battery pack are listed as follows:

Operating Temperature Range:	from +5° F to +140° F (-15° C to +60° C)
Charging Temperature Range:	from +5° F to +122° F (-15° C to +50° C)
Storage Temperature Range:	from -40° F to +140° F (-40° C to +60° C)

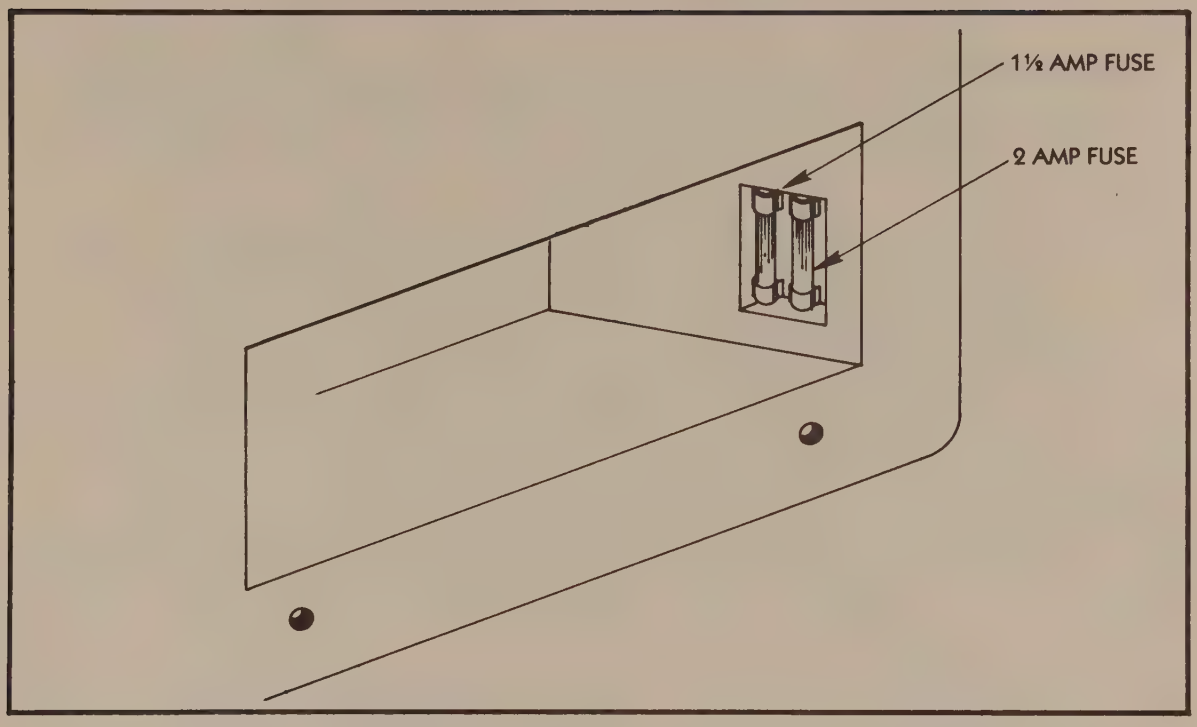


FIGURE 2-2 LOCATION OF POWER FUSES IN BATTERY COMPARTMENT

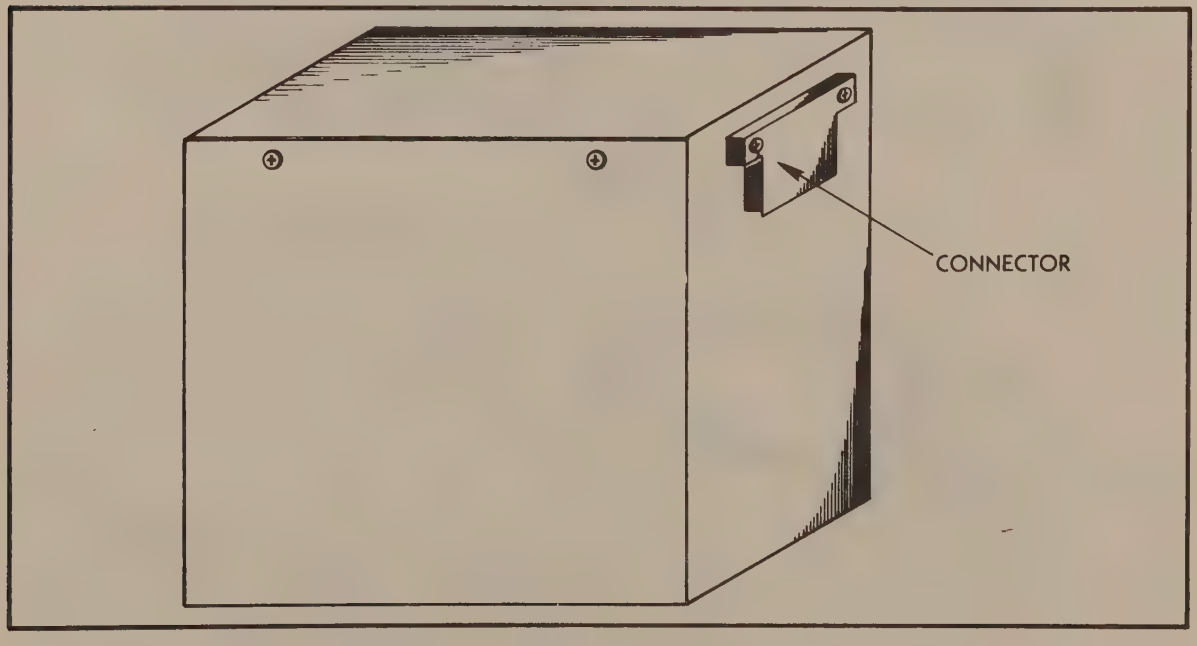


FIGURE 2-3 BATTERY PACK

2.4 DESCRIPTION OF ACCESSORIES

Standard Accessories

The STANDARD ACCESSORIES supplied with the Model 820/820M instrument are listed below and shown in Figure 2-4.

A. Accelerometer, Model 970, Part No. 19697.
B. Pickup Cable for Model 970, 12-foot, Part No. 20431.
C. Extension Probe (9-inch) for connection to 970, or optional 544 Velocity Pickup, Part No. 01103.
D. Battery Charger, Model 426, Part No. 28560.
E. Thermal Paper for Printer/Plotter, Part No. 24444, (6 rolls supplied).
F. Instruction Manual, Part No. 23936.
G. Accessory Case, Part No. 25345.

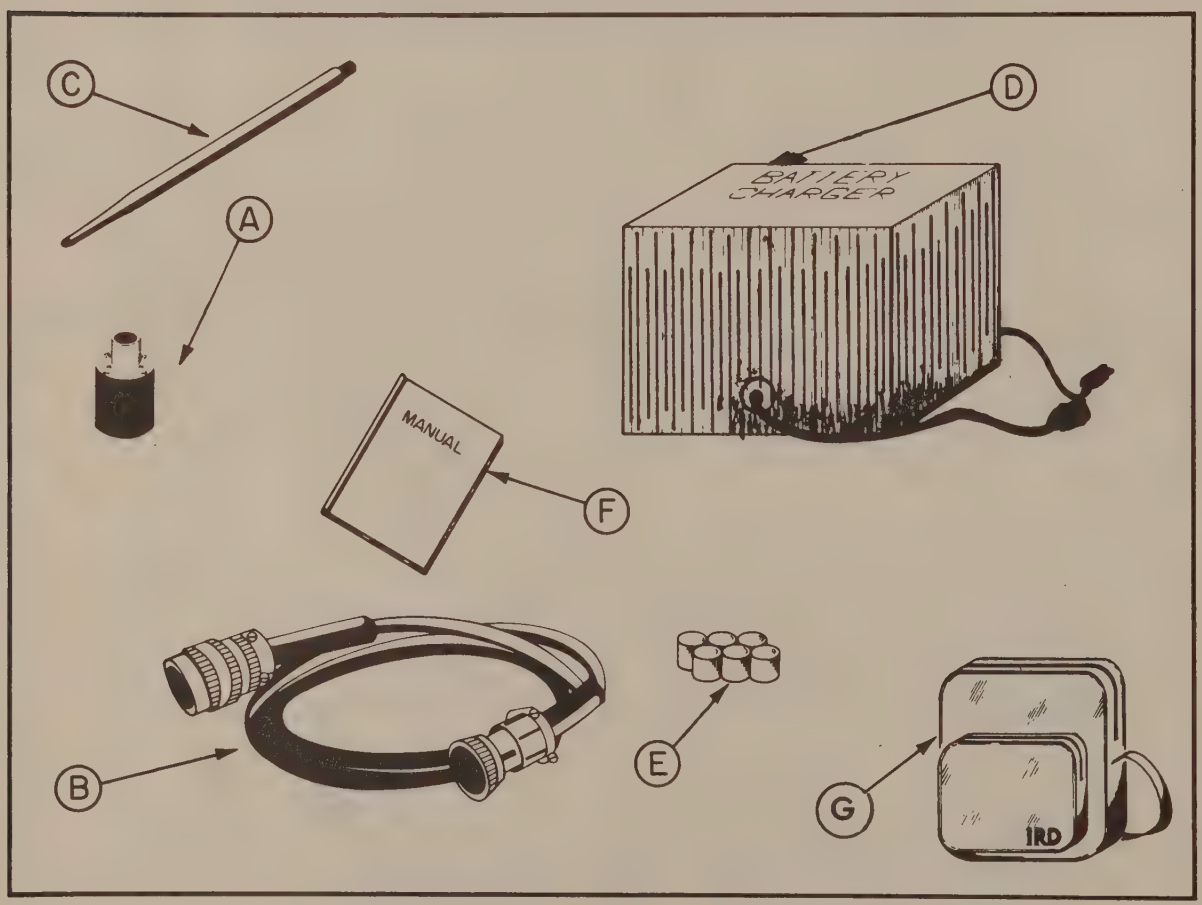


FIGURE 2-4 STANDARD ACCESSORIES

Optional Accessories

The OPTIONAL ACCESSORIES which are also available for use with the Model 820/820M instrument are shown in Figures 2-5A and 2-5B.

Optional Accessories included in Figure 2-5A:

A. Extra Battery Pack Charger Adapter, Part No. 24458.
B. Model 544 Velocity Transducer, Part No. 4526.
C. 12-ft. (3.7 m) Pickup Cable for Model 544 Transducer, Part No. 20433.
D. 25-ft. (7.6 m) Extension Cable for Model 544 Transducer, Part No. 21045.
E. 50-ft. (15.2 m) Extension Cable for Model 544 Transducer, Part No. 21049.
F. Magnetic Holder for Model 970 Accelerometer, Part No. 24746.
G. Magnetic Holder for Model 544 Transducer, Part No. 4332.
H. 25-ft. (7.6 m) Extension Cable for Model 970 Accelerometer, Part No. 21044.
I. 50-ft. (15.2 m) Extension Cable for Model 970 Accelerometer, Part No. 21048.
J. Model 308 Vibration/Sound Level Meter
K. One Lot (48 rolls per lot) of chart paper; sold only by lot, Part No. 24444.

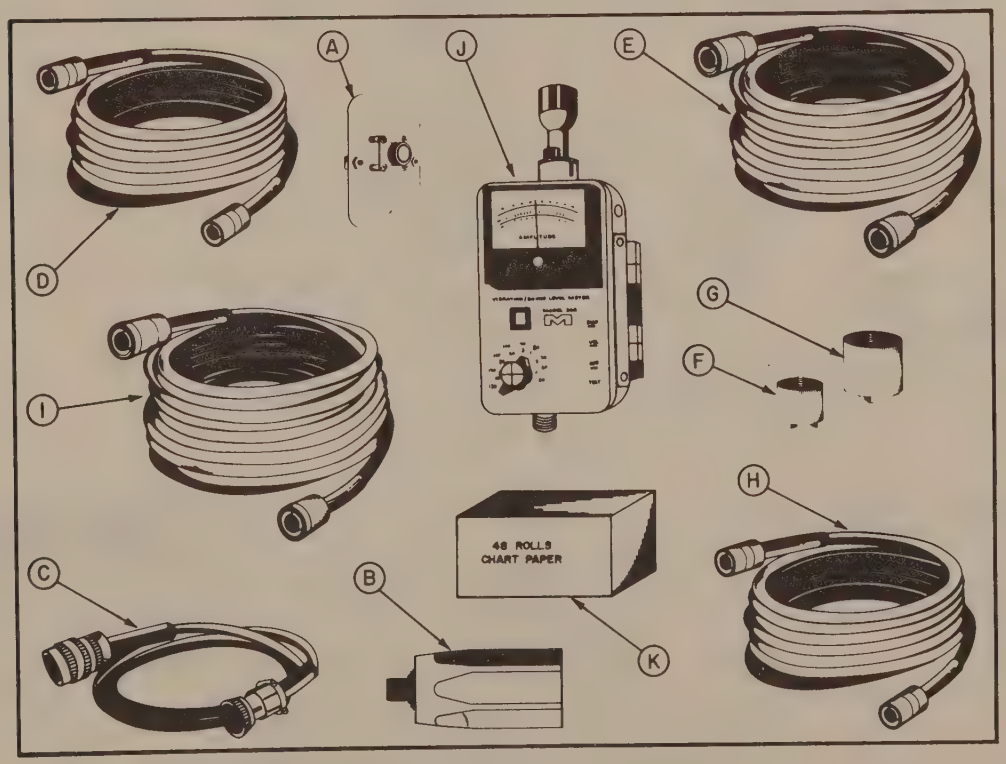


FIGURE 2-5A OPTIONAL ACCESSORIES

Optional Accessories included in Figure 2-5B:

A. 25-ft. (7.6 m) Photoelectric Tachometer Signal Cable, Part No. 24761.
B. Photoelectric Reference (Tachometer) Pickup, Part No. 21000.
C. Roll (150 ft., 46 m) of 1/4 inch (1 cm) reflective tape; required for operation of Photoelectric pickup, Part No. 21200.
D. 25 ft. (7.6 m) Electromagnetic Tachometer Signal Cable, Part No. 24762.
E. Electromagnetic Reference (Tachometer) Pickup, Part No. 5106.
F. Universal Mounting Fixture for Photoelectric or Electromagnetic Pickup, Part No. 5920.
G. Extra Battery Pack, Part No. 24400.
H. Calibrator, Part No. 21073.
I. Vibration Chart Storage Notebook with 50 filler sheets, Part No. 25864.
J. Pack of 100 Extra Notebook Filler Sheets, Part No. 25865.
K. 12 ft. (3.7 m) Non-Contact signal sensor pickup cable, w/2 spade lugs, Part No. 22874.
L. 12 ft. (3.7 m) Non-Contact signal sensor pickup cable, w/BNC connector, Part No. 24809.

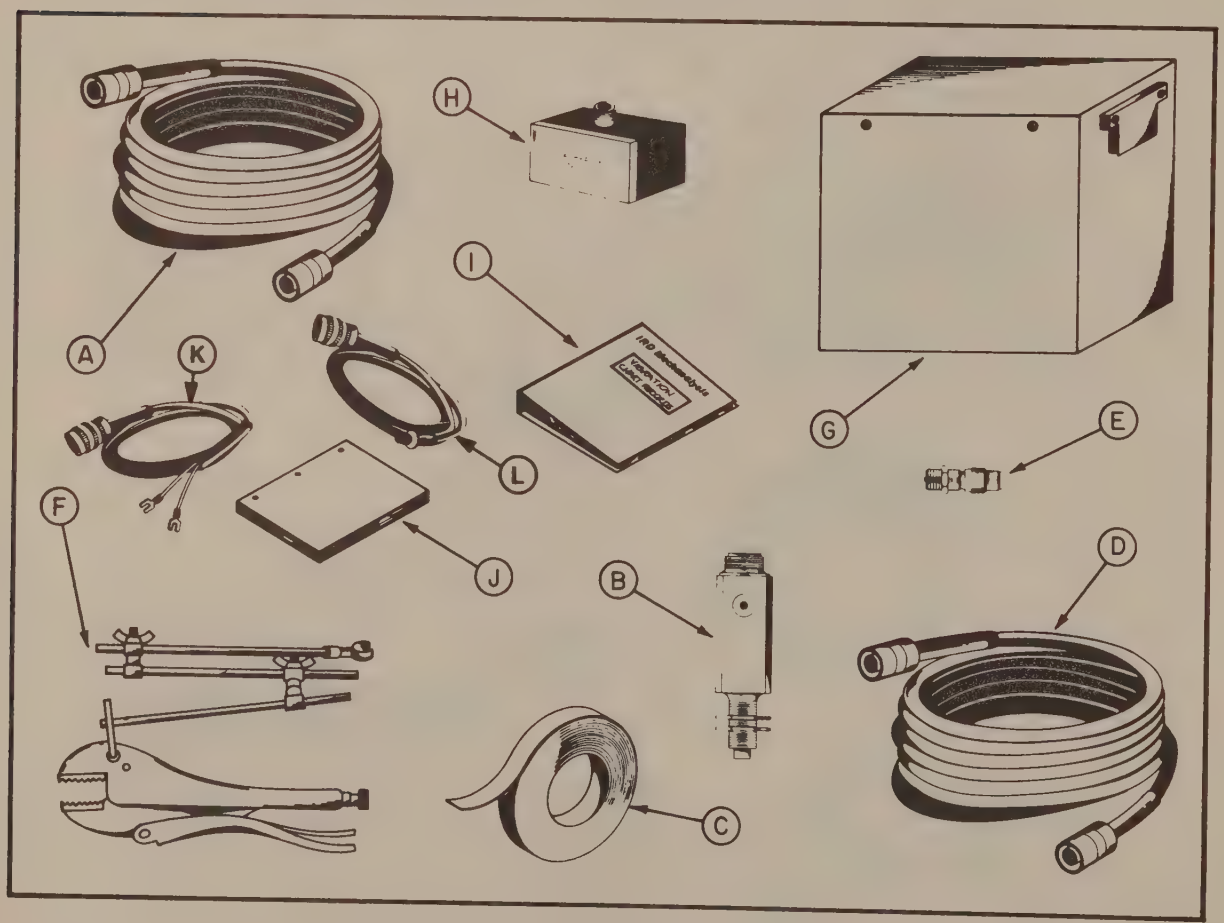


FIGURE 2-5B OPTIONAL ACCESSORIES

III PREPARATION FOR OPERATION

3.1 ACCESSORY CABLE CONNECTIONS

1. Model 970 Cable Connections

Connect the threaded connector of the Pickup Cable to the threaded receptacle on the Model 970 Accelerometer.

Connect the twist-lock connector at the analyzer end of the Pickup Cable to the twist-lock receptacle on the front panel of the analyzer.

If an Extension Cable is required, disconnect the threaded connector from the Model 970 receptacle, and connect the threaded male receptacle of the Extension Cable to the threaded female connector at the end of the Standard Pickup Cable.

Connect the threaded female connector at the pickup end of the extension cable to the male threaded receptacle on the accelerometer.

2. Model 544 Cable Connections

If the optional Model 544 Velocity Pickup is to be used, rather than the Model 970, the same cable connection procedure is followed using the Model 544 Pickup cable and extension cables.

3. Model 308 Cable Connections

The optional Model 308 Vibration/Sound Level Meter can be used when it is desired to measure sound rather than vibration. To connect this accessory, the Model 544 cable connection procedure is followed, with the exception that the Model 308 output receptacle is connected in place of the Model 544.

4. Non-Contact Signal Sensor Cable Connections

A Non-Contact Pickup signal sensor with a sensitivity of 200 mV/mil (8 mV/um) may be connected to the Model 820 instrument using the optional Non-Contact signal sensor cable (P/N 22874). In this case, the same cable connection procedure is followed as when using the Model 970 Accelerometer.

5. Non-Contact Monitor Cable Connections

If the optional Non-Contact Monitor Cable (P/N 24809) is used to connect to a non-contact monitor having a 200 mV/mil (8 mV/um) sensitivity, the same cable connection procedure is followed as when using the Model 970 Accelerometer.

6. Tachometer Cable Connections

If the optional tachometer is to be used, the photoelectric, or electromagnetic tachometer cable is connected to the Model 820/820M TACH/CHARGER input receptacle. The other end of the tachometer cable connects to either the photoelectric reference, or electromagnetic pickup, as appropriate.

7. Battery Charger Cable Connections

To connect the Battery Charger to the Model 820/820M, connect the threaded connector at the external end of the Battery Charger Output Cable to the Model 820/820M TACH/CHARGER input receptacle.

3.2 TURN-ON SELF CHECK

1. Set the ON-OFF power switch to ON. This turns on the red Self Check LED light, indicating the initiation of the microprocessor circuit check. The Self Check light automatically extinguishes in approximately 6 seconds if the microprocessor and associated circuit checks are satisfactory. An automatic printout is also obtained, which indicates that the checks were satisfactory.

2. If the light fails to turn on, it means that a fault is present: a defective light, no battery power, or a defect in the microprocessor. If the light remains steadily lit after the 6 second check, it indicates a fault in the microprocessor.

3. After the turn-on check is completed, the red LED will normally start to blink as a reminder to the operator that the power is on.

3.3 BATTERY CHECKS

1. Set the ON-OFF switch to the ON position.

2. Set the FUNCTION SELECTOR to BATT 1, and check that the AMPLITUDE METER indicates somewhat above the LO point in the LO-BATTERY-HI area of the lower meter scale. Battery 1 is fully charged when the meter needle registers at about 1/3 the distance from LO to HI. NOTE: While both batteries have the same "LO" battery position on the meter scale, their fully charged indications are different.

3. Set the FUNCTION SELECTOR to BATT 2, and check that the AMPLITUDE METER indicates somewhat above the LO point in the LO-BATTERY-HI area of the lower meter scale. Battery 2 is fully charged when the meter needle registers at about 2/3 the distance from LO to HI.

NOTE: If the specified meter indications are obtained in the above two checks, the internal batteries have sufficient output voltages for powering the analyzer and printer/plotter circuits. Otherwise, the batteries must be recharged or replaced before using the analyzer.

* CAUTION *

Do not operate the instrument if the battery checks indicate that either battery voltage falls below the LO point on the meter Lo-Battery-Hi Scale.

3.4 TEST MODE CHECK

1. With the ON-OFF switch set to ON, set the AMPLITUDE selector to TEST.

2. Set the UNITS selector to DISP, VEL or ACCEL.

3. Check that the AMPLITUDE METER indicates between 0.75 and 0.85 on the upper meter scale. If this indication is obtained, the analyzer circuits are operating properly.

4. Set the FUNCTION selector to BROAD. With the AMPLITUDE selector set to TEST, momentarily set the PLOT-ADV/PAUSE switch to PLOT and then release to the center position.

5. Check that a spectrum plot of the TEST SIGNAL is produced from 600 to 600K CPM by the Printer/Plotter. This signal consists of a square-wave voltage at 1.2K CPM (20 Hz) with an amplitude of 0.8 volts. The spectrum plot should include the 1.2K CPM primary component at about 70% of full scale, and the odd harmonics to approximately 13.2 KCPM. If this plot is obtained within approximately 36 seconds, the Printer/Plotter and associated analyzer circuits are functioning correctly. Figure 3-1 shows an example of this spectrum test plot.

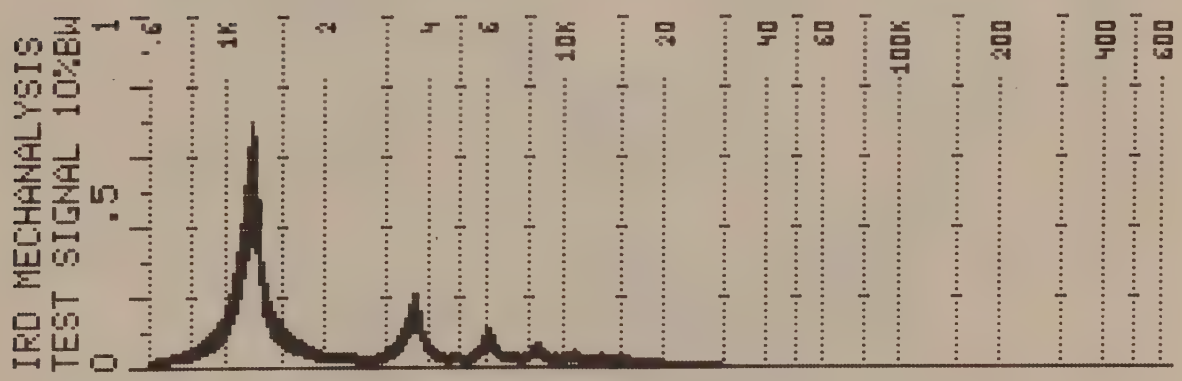


FIGURE 3-1 BROAD SPECTRUM TEST PLOT

NOTE: A similar spectrum plot can also be obtained in the SHARP mode to check that the filter circuits are also operating properly in this mode.

3.5 RECHARGING THE INTERNAL BATTERIES

1. Connect the Model 426 Battery Charger output cable to the threaded TACH/CHARGER INPUT receptacle on the front panel of the analyzer.

2. Connect the Battery Charger power cord to the AC voltage supply receptacle. Voltages of 108-132 and 198-242 VAC, 50 to 60 Hz, single phase AC can be used; however, the setup switches of the Battery Charger must be set to the correct positions for the voltage to be used (either "120" or "220"). Refer to Figure 3-2 for the Charger connection details.

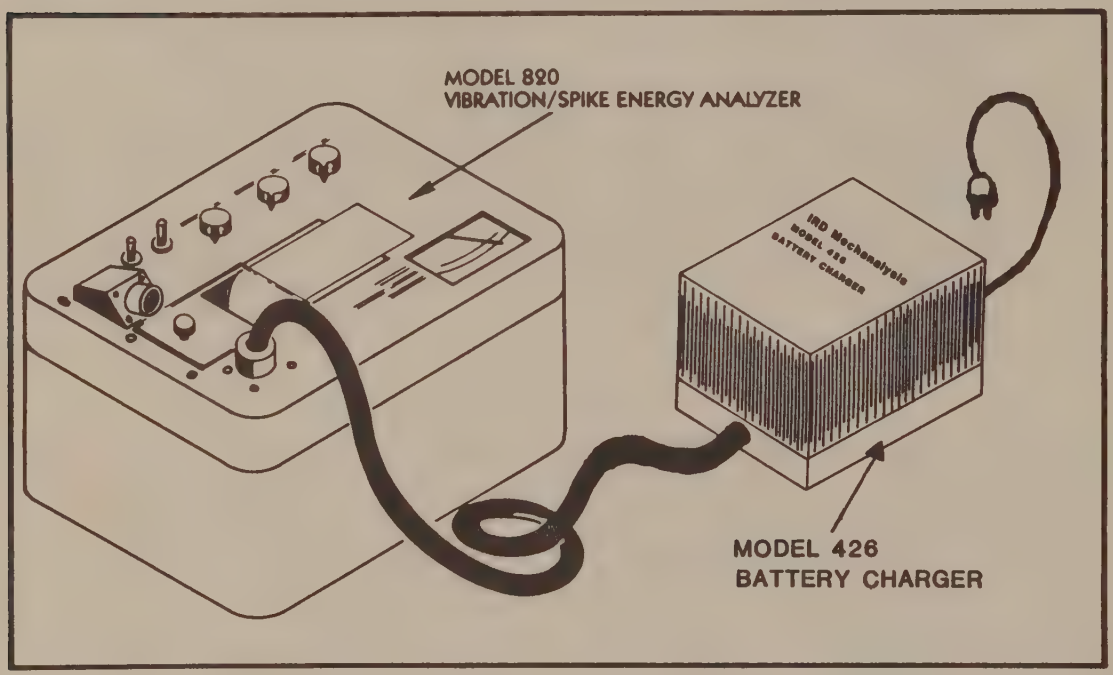


FIGURE 3-2 RECHARGING MODEL 820 BATTERIES

3. The Battery Charger requires approximately 10 hours to fully recharge the analyzer batteries. The analyzer must not be turned on during charging in order to achieve a full charge within this time period.

* CAUTION *

Do not attempt to charge the analyzer batteries with any charger other than the Model 426 Battery Charger.

3.6 REPLACING BATTERY PACK

1. To replace the battery pack, release the two captive screws and remove the battery compartment cover plate.

2. Pull the battery pack straight out.

   Insert a new (or recharged) battery pack, making sure that the battery power connector (reference Figure 2-5) is aligned with the battery compartment battery power receptacle.

3. Replace the battery cover and the two retaining screws.

3.7 RECHARGING SPARE BATTERY PACK

A spare Battery Pack, Part No. 24400, can also be charged (when not installed in the analyzer) by use of the Model 426 Battery Charger and the Extra Battery Charger Adapter (Part No. 24458). The procedures used are similar to those for recharging the internal battery, with the exception that the charger output cable is connected to the Extra Battery Charger Adapter and Charger Adapter is connected to the spare battery pack. See Figure 3-3.

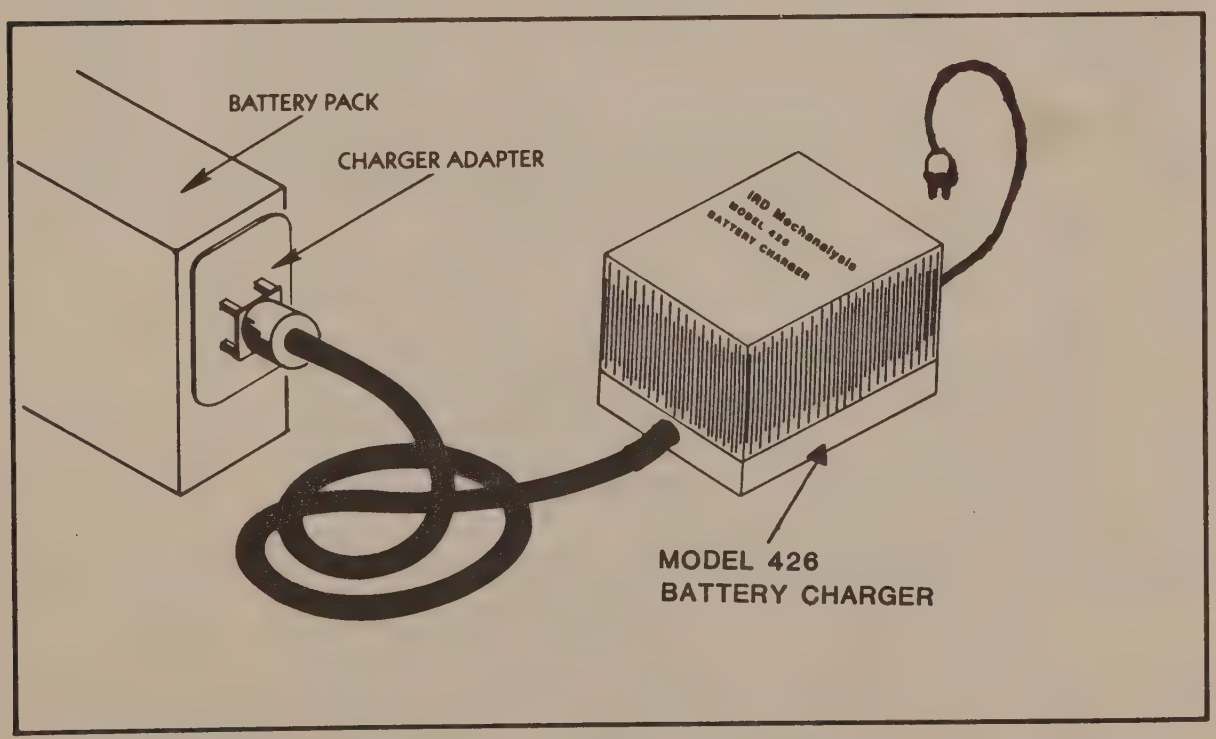
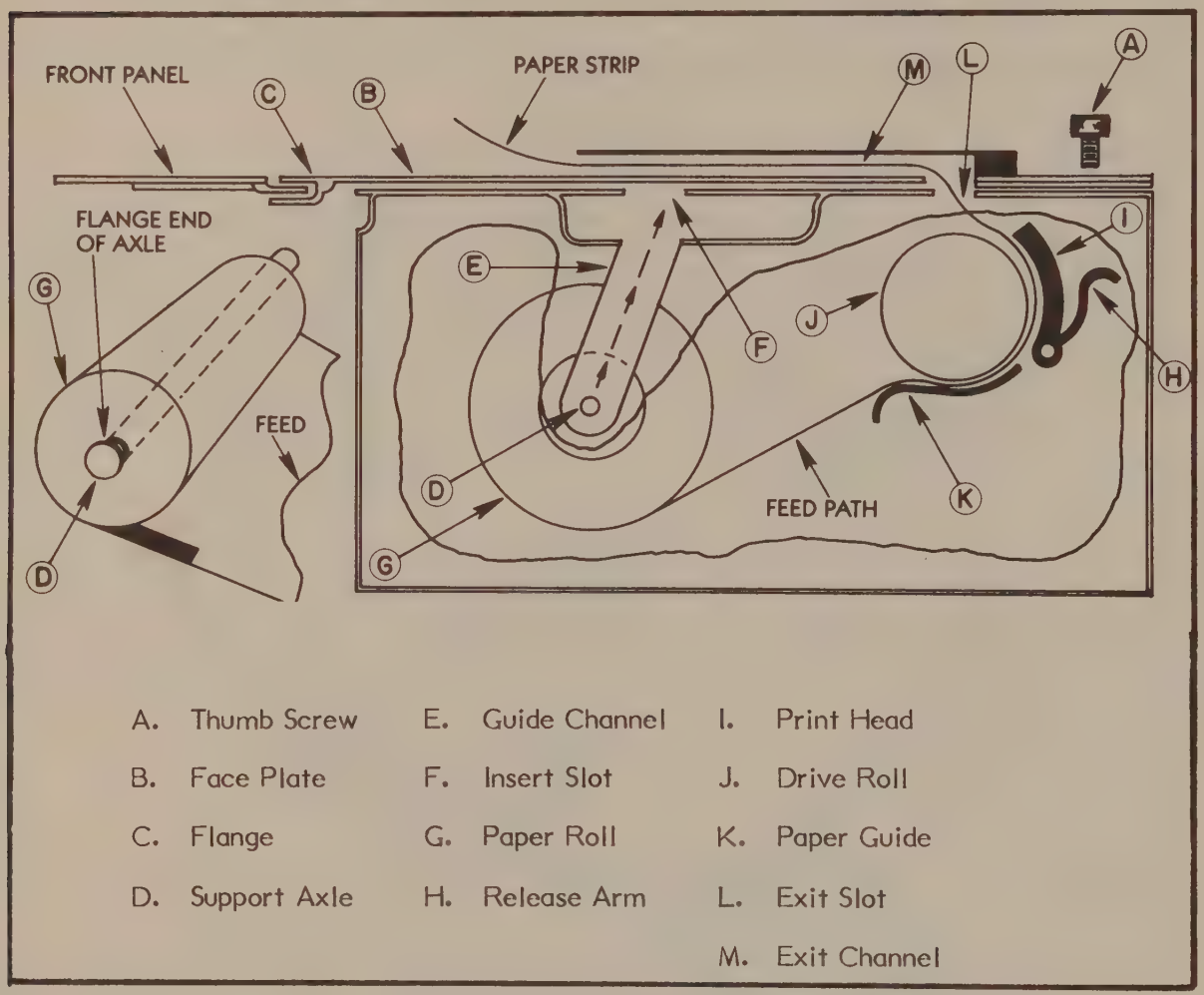


FIGURE 3-3 RECHARGING SPARE BATTERY PACK.

3.8 LOADING CHART PAPER

To install a new roll of chart paper, first unscrew the thumb fastener and remove the cover plate. Lift out the old roll and load the new roll on the spindle, making sure the paper unrolls from under the roll. Lift the print head (which is spring-loaded against the friction roller) away from the roller to allow the paper to be fed under the roller and up past the head. Roll out some extra paper by hand turning the friction roller, and slip this paper out through the exit slot in the cover plate as it is being reassembled. See Figure 3-4.



A. Thumb Screw	E. Guide Channel	I. Print Head
B. Face Plate	F. Insert Slot	J. Drive Roll
C. Flange	G. Paper Roll	K. Paper Guide
D. Support Axle	H. Release Arm	L. Exit Slot
		M. Exit Channel

FIGURE 3-4 CHART PAPER LOADING GUIDE

3.9 SETTING CHART PAPER SPEED

Three chart paper speeds are provided in the FILTER OUT mode to permit the operator to select the speed which best suits the measurement requirements. The SLOW chart speed is used for long-term recording, the MEDIUM speed is used for general purpose recording, and the FAST speed is used to record rapidly changing vibrations.

NOTE: The Chart Paper Speed selector does not operate in the BROAD or SHARP frequency analysis modes.

The toggle switch used to select the chart speeds is located inside the chart paper compartment along the rear side as shown in Figure 3-5 below.

Mode	Paper Speed	Plotted (Points/Sec)
Slow	.65 in. (1.7 cm) per min.	0.5
Medium	3.25 in. (8.3 cm) per min.	2.5
Fast	13 in. (33 cm) per min.	10.0

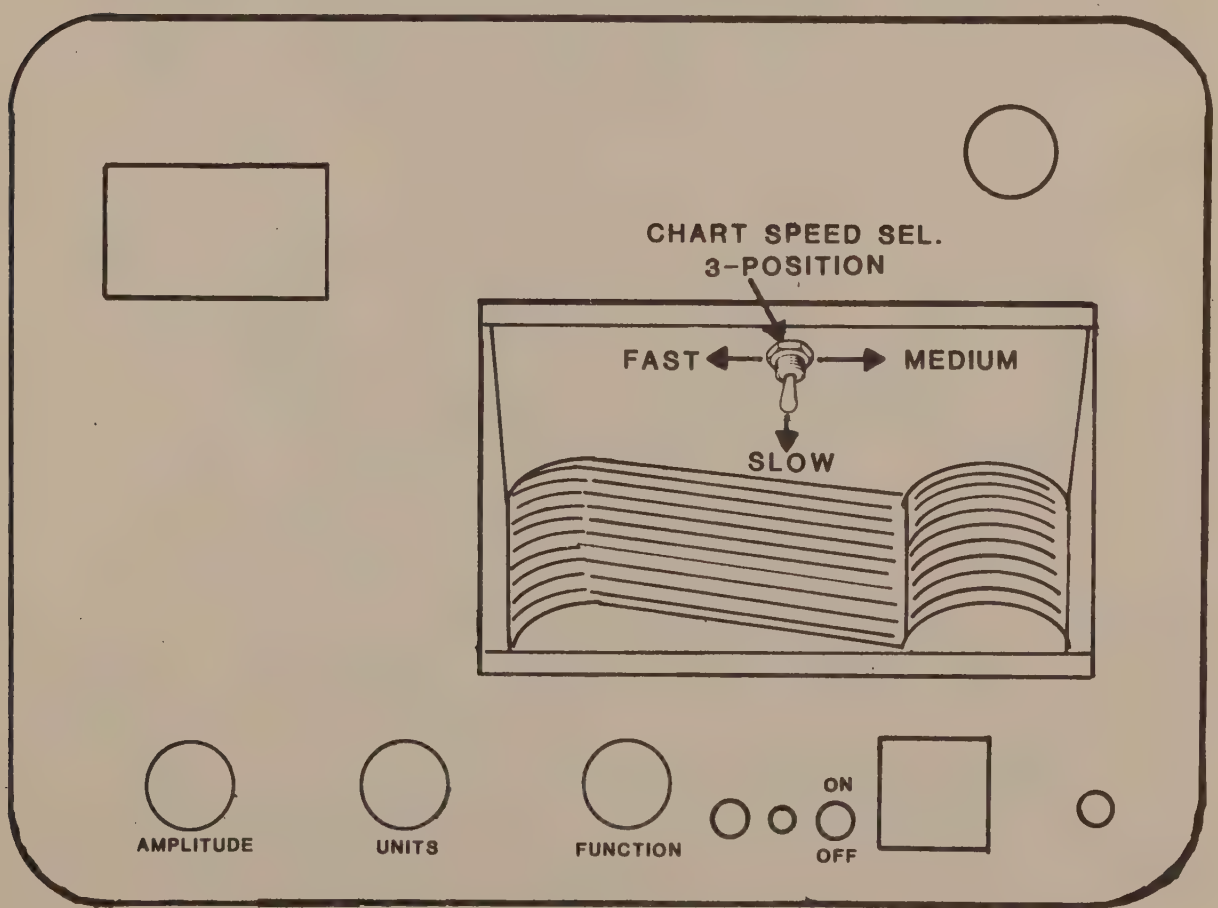


FIGURE 3-5 LOCATION OF CHART SPEED SELECTOR

IV OPERATION

4.1 GENERAL

This Chapter contains instructions for operating the Model 820/820M Vibration/ SPIKE ENERGY Analyzer with the standard Model 970 Accelerometer, as well as the optional Model 544 Velocity Pickup, and the Model 308 Vibration/Sound Level Meter. In addition, instructions are provided for operating the Model 820 instrument with the output from either a Non-Contact signal sensor or a Non-Contact monitor.

Information on the significance of the vibration levels (displacement, velocity, acceleration) measured is provided by guideline severity charts in Appendix B. Also, procedures for evaluating SPIKE ENERGY units are given in Appendix C.

4.2 VIBRATION SPECTRUM PLOTTING

The Model 820/820M generates a vibration spectrum by automatically stepping the filter in either the BROAD (10% BW) or SHARP (5% BW) mode across the frequency range in small increments. At each frequency where the filter dwells, the filtered amplitude (level) is sampled and plotted as a "frequency line" at the proper location on the frequency axis of the chart. Examination of a spectrum plot will show that it consists of contiguous "frequency lines" (264 for a BROAD spectrum and 430 for a SHARP spectrum) which cover the frequency range from 600 to 600,000 CPM. Figures 4-1A and 4-1B show examples of BROAD and SHARP spectrum plots.

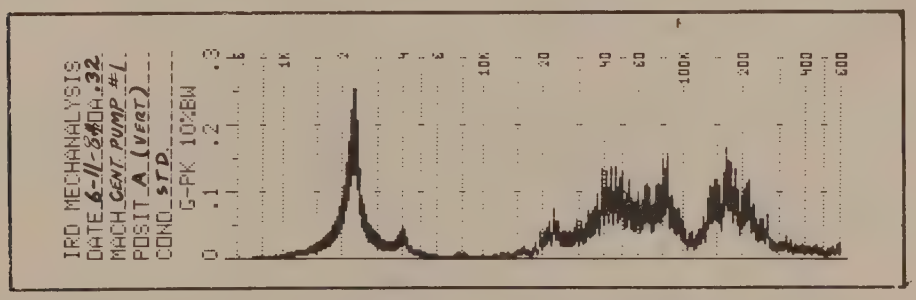

IRD MECHANALYSIS
DATE 6-11-84 DA.32
MACH CENT. PUMP #1
POSIT A (VERT)
COND STD.
G-PK 10%BW
0 .1 .2 .3
1K 2 3 4 5 6 10K 20 30 40 50 60 80 100K 200 300 400 500 600

FIGURE 4-1A EXAMPLE OF BROAD SPECTRUM PLOT

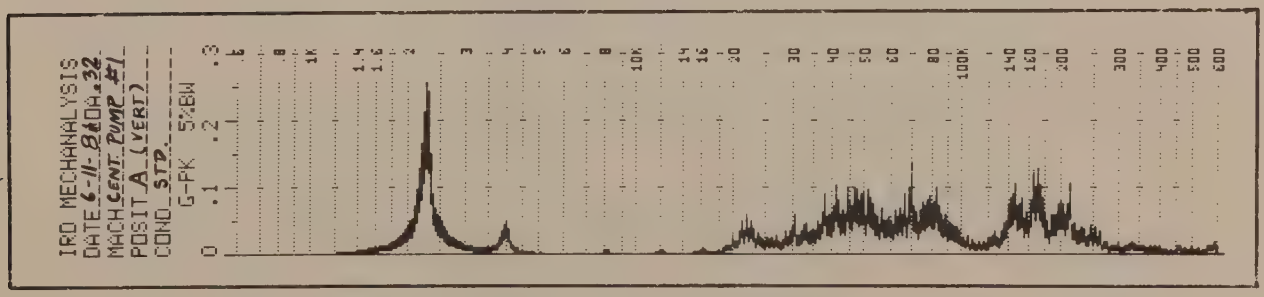


FIGURE 4-1B EXAMPLE OF SHARP SPECTRUM PLOT

4.3 OBTAINING VIBRATION SPECTRUM PLOT

To obtain a vibration spectrum plot, perform the following procedure:

1. Set up the analyzer for operation as described in Chapter III.

2. Select the proper transducer for the specific type of measurement to be performed.

3. Attach the transducer to the machine at the appropriate location.

4. Set the UNITS Selector to DISplacement, VELocity or ACCELeration. Note that a spectrum plot cannot be obtained in the SE mode.

5. Adjust the AMPLITUDE selector to obtain an Amplitude Meter reading of 1/3 Full Scale to Full Scale. Details on adjusting the selector to obtain enhanced amplitude resolution of the plotted peaks are described in Step 9.

6. Set the FUNCTION Selector to BROAD (10% bandwidth), or SHARP (5% bandwidth). The BROAD filter mode provides adequate frequency resolution for most applications. When greater detail of the frequency peaks is required, however, the SHARP filter mode may be used.

7. Start the spectrum plot (for the 600 to 600K CPM range) by momentarily pressing the PLOT-ADV/PAUSE switch to PLOT once, and then releasing it to the center position. A BROAD spectrum plot will be generated in about 44 seconds, and a SHARP spectrum plot in about 102 seconds. The plotting automatically terminates on completion of the spectrum.

   To initiate the plot from either 6K or 60K CPM, press the switch to PLOT twice in succession, or three times in succession, respectively. Starting from 6K CPM, a BROAD mode plot will be generated in about 24 seconds, and a SHARP mode plot in about 35 seconds. Starting from 60K CPM, the approximate plotting times are 17 seconds for the BROAD mode plot and 21 seconds for the SHARP mode plot.

   The frequency peaks are identified by visually observing the relationship of the peaks to the frequency graticule lines. If more accurate identification of the peaks is required, the Frequency Calculation Method described in Appendix D may be used.

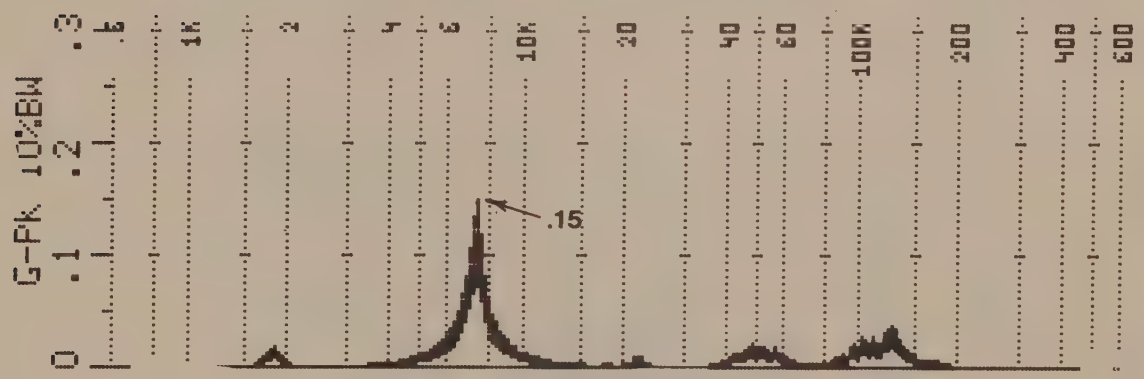
8. To terminate a partially plotted spectrum, move the PLOT-ADV/PAUSE switch momentarily to PLOT, and then release it.

NOTE: If any switch position is changed (AMPLITUDE, UNITS, or FUNCTION) while a spectrum is being plotted, the plot will be immediately terminated.

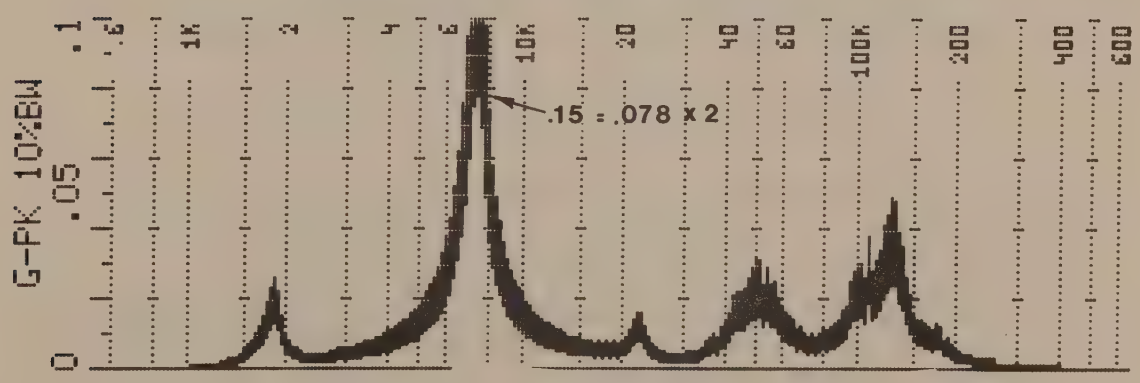
9. If the frequency peaks in the spectrum do not exceed 1/3 of Full Scale, better spectrum amplitude resolution can be obtained by switching the AMPLITUDE selector to the next lower (more sensitive) amplitude position.

   If still further amplitude resolution of some low amplitude frequency peaks is desired, the AMPLITUDE Selector can be switched to one lower (more sensitive) amplitude position. In this case one, or more, of the larger peaks will be above Full Scale. As long as these peaks are not more than 60% above Full Scale, their amplitudes can still be accurately determined.

   To determine the amplitude of an over-scale peak, first note the amplitude at the lower end of the peak "frequency line." This value equals one-half the correct amplitude at that frequency. By doubling this half-amplitude, the correct amplitude of the peak can be determined. For example, if the analyzer is set to the 10 mil (300 um) range and the half-amplitude is 7 mils peak-peak (178 um peak-peak), then the correct amplitude, which will be above full scale, will be 14 mils peak-peak (356 um peak-peak). As long as the half-amplitude is not greater than 80% of full scale, then the correct full scale amplitude can be determined. Figure 4-2 shows an example of the procedure for measuring the correct amplitude for an over-scale peak.



BROAD SPECTRUM - ON SCALE



BROAD SPECTRUM - OVER SCALE

FIGURE 4-2 EXAMPLE SHOWING MEASUREMENT OF TRUE AMPLTIUDE FOR OVER SCALE PEAK

10. If an improper UNITS, or FUNCTION, switch position is selected, when the PLOT-ADV/PAUSE switch is moved to PLOT an error printout will be generated as follows:

OPERATOR ERROR - IMPROPER SWITCH CONFIGURATION

The switch positions which will result in this error printout include: DISPL with Model 970 Accelerometer connected, ACCEL with Model 544 Velocity Pickup connected, and BROAD or SHARP with SE. In addition, an attempt to plot with the FUNCTION Selector in the BATT 1 or BATT 2 position will also cause the error message to be printed out.

4.4 OBTAINING SOUND (NOISE) SPECTRUM PLOT

The Model 820/820M can generate a sound spectrum plot in the same manner as the Vibration Spectrum. An example of a Sound Spectrum plot is shown below in Figure 4-3.

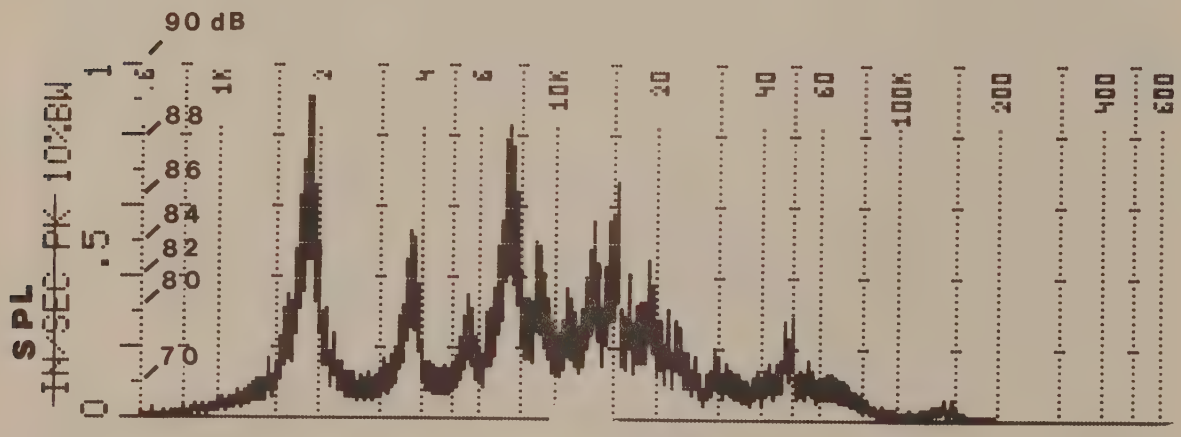


FIGURE 4-3 TYPICAL SOUND SPECTRUM PLOT

To obtain a sound spectrum plot, perform the following procedures:

1. Set up the analyzer for operation as described in Chapter III.

2. Locate the Model 308 Vibration/Sound Level Meter so that it is correctly positioned to measure the sound. See the Model 308 Operating Instruction Manual for further details.

3. Set the UNITS Selector to VELocity.

4. Set the AMPLITUDE Selector to 1. (10 for metric units)

5. Adjust the AMPLITUDE Selector on the Model 308 to obtain an Amplitude Meter reading of 1/3 Full Scale to Full Scale on the Model 308 Amplitude Meter. The Amplitude Meter on the Model 820/820M should indicate approximately the same meter reading as on the Model 308.

   Although the spectrum plot will print out the heading "IN/SEC-PK", the actual units recorded will be "dB" (decibels). Further, the amplitude scale printout will show a full scale value of 1. This should be corrected to read the dB value of the Model 308 Amplitude Selector position plus 10dB. For example, if the Model 308 Amplitude Selector is set to 80 dB, then the full scale value on the spectrum plot will be 90dB. To mark the amplitude scale of the plot with additional dB values, refer to the dB scale on the Model 308 Meter, or use the approximate values listed in Table 4-1.

   In Table 4-1, the relationship between linear scale values on the spectrum plot and their dB equivalents is described. In general, the actual dB values to be read from the plot scale are calculated by subtracting the dB equivalence factor (for the particular scale percentage listed) from the full scale dB value determined above.

TABLE 4-1 LINEAR SCALE TO dB EQUIVALENCE

LINEAR SCALE PERCENTAGE	dB EQUIVALENCE FACTOR	EXAMPLE (FOR 90 dB FULL SCALE)
100% Full Scale	0 dB	90 dB
79 Full Scale	-2	88 dB
63 Full Scale	-4	86 dB
50 Full Scale	-6	84 dB
40 Full Scale	-8	82 dB
32 Full Scale	-10	80 dB
10 Full Scale	-20	70 dB

6. To start the Sound Spectrum plot, the procedures listed in Steps 6 through 8 of Section 4.3 are followed.

7. Additional amplitude resolution on the plot can be obtained by switching the Model 820/820M AMPLITUDE selector to lower (more sensitive) positions as described in Step 9 of Section 4.3.

4.5 OBTAINING VIBRATION, SOUND, OR SPIKE ENERGY UNITS VS TIME PLOT

In the FILTER OUT mode, the analyzer samples the unfiltered (overall) amplitude at periodic intervals and plots the amplitude as a point on the chart each time a sample is taken. The sampling rate is determined by the chart paper speed as follows: SLOW - 0.5 points per second, MEDIUM - 2.5 points per second, FAST - 10 points per second. Figure 4-4 shows examples of each of these plots.

To obtain an Amplitude (level) vs. Time Plot, proceed as follows:

1. Set up the analyzer for measurement of:

   VIBRATION by following steps 1 through 5 of Section 4.3.

   SOUND by following steps 1 through 5 of Section 4.4.

   SPIKE ENERGY units by following steps 1 through 5 of Section 4.3, but setting the UNITS selector to SE.

NOTE: The procedure for setting the AMPLITUDE selector for the Amplitude (level) vs. Time Plot differs from that of the Spectrum plot. For the Amplitude vs. Time plot, the Filter Out amplitude level should not be permitted to exceed full scale, since there is no way to calculate the correct amplitude of levels exceeding full scale as can be done in the spectrum (frequency) mode.

2. Select the chart speed which matches the measurement application. For example, if the purpose of the measurement is to watch the vibration trend over 30 minutes, or longer, the SLOW chart speed should be selected. If, however, it is desired to observe rapid vibration changes, the FAST speed will provide the most detail. For most applications, the MEDIUM chart speed is a good compromise between obtaining adequate details of rapid changes and avoidance of excessive use of chart paper when observing changes of longer duration.

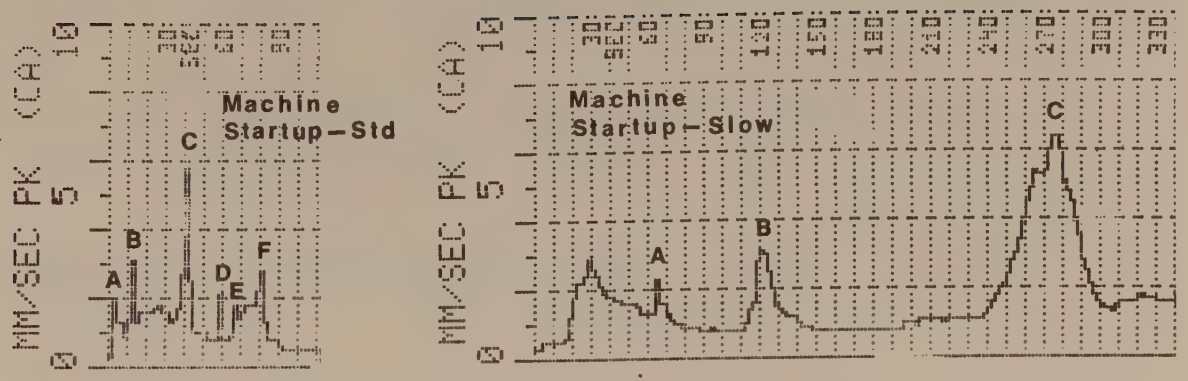
3. Set the FUNCTION selector to FILTER OUT.

4. Initiate the Amplitude (level) vs. Time plot by momentarily moving the PLOT-ADV/PAUSE switch to the PLOT position.

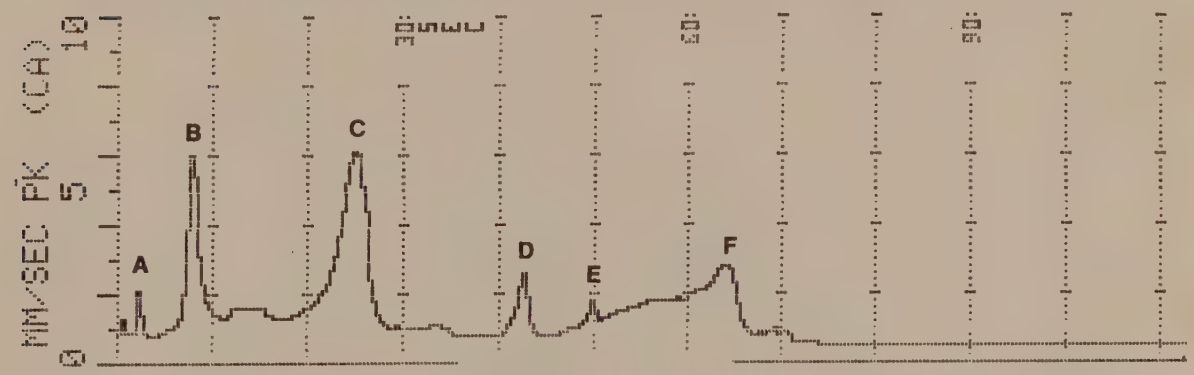
5. The analyzer will continue to plot the unfiltered (overall) signal until the plot is manually terminated by once again momentarily moving the PLOT-ADV/PAUSE switch to the PLOT position.

6. If the overall vibration (or sound) of a machine is to be measured as it comes up to speed, the Amplitude range selected should take into account the fact that the vibration (or sound) level will probably increase by a large amount from startup to full speed.

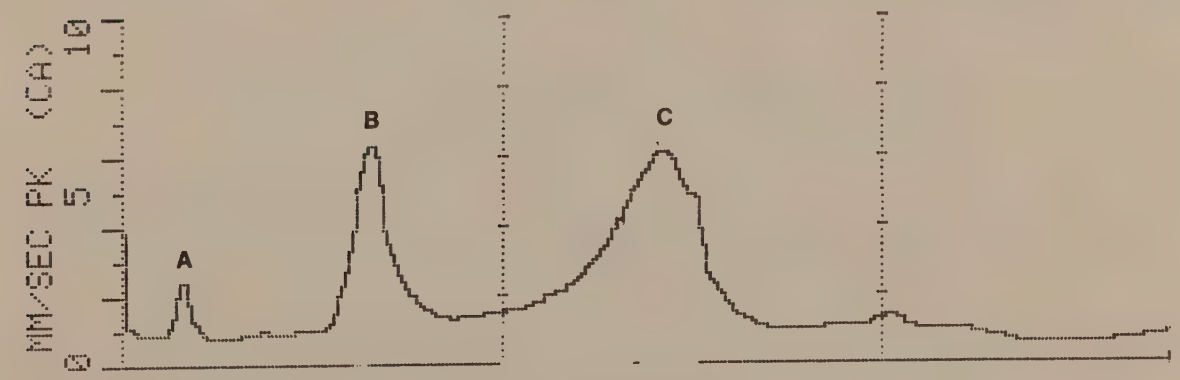
7. If the signal level increases above full scale, or drops too low for good visual resolution, the AMPLITUDE selector can be changed to bring the signal properly on-scale without terminating the plot. When the change is made, however, the plot will be momentarily interrupted by the printout of the new correct Amplitude range scale.



SLOW SPEED (.5 POINTS/SEC) AMPL VS TIME PLOT



MEDIUM SPEED (2.5 POINT/SEC) AMPL VS TIME PLOT



FAST SPEED (10 POINTS/SEC) AMPL VS TIME PLOT

FIGURE 4-4 EXAMPLES OF AMPLITUDE VS TIME PLOTS

NOTE: The capability to change switch positions without terminatng the plot is only provided for the AMPLITUDE selector, and only in the FILTER OUT mode. It is not provided in the BROAD or SHARP mode.

8. If it is desired to pause in the plotting of the Amplitude (level) vs. Time, the PLOT-ADV/PAUSE switch is momentarily moved to the ADV/PAUSE position. This will stop the plotting. When the PLOT-ADV/PAUSE switch is again momentarily moved to PLOT, the plotting will resume after a new amplitude scale has been automatically printed.

9. If a number of bearings, or gears, of a machine are to be checked for defects using SPIKE ENERGY signal measurements, an alternate technique may prove to be effective, as shown in Figure 4-5.

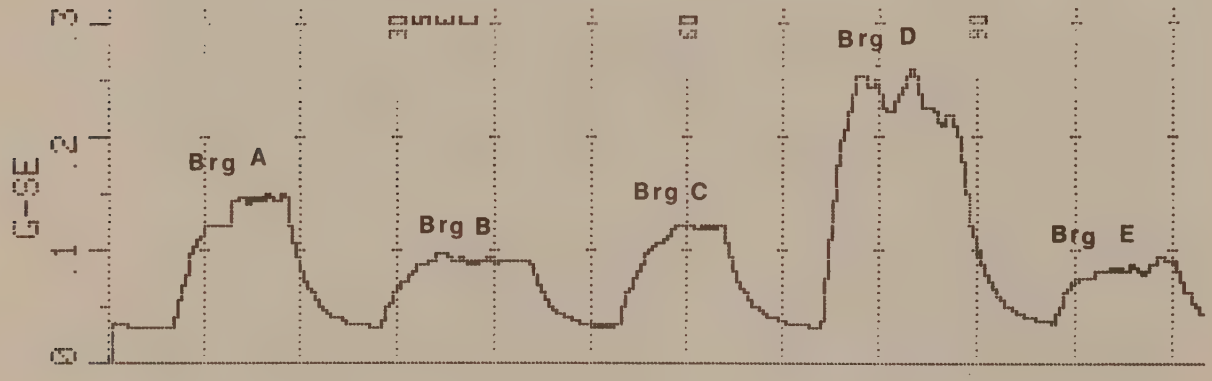


FIGURE 4-5 AN ALTERNATE PROCEDURE FOR OBTAINING AMPL. VS TIME MEASUREMENTS IN THE G-SE MODE

To perform this measurement technique, proceed as follows:

a) Before applying the 9 inch probe (attached to the Model 970) to the bearing housing, set the AMPLITUDE Selector to an intermediate value such as 0.3 or 1.0 g-SE.

b) Set the chart paper speed to MEDIUM (2.5 points/sec.).

c) Momentarily move the PLOT-ADV/PAUSE switch to the PLOT position to initiate the plotting. Note that the measured level should be approximately zero until the probe touches the bearing, since the low frequency vibrations of the operator's hand motion is filtered out by the ultrasonic circuits in the SPIKE ENERGY units mode.

d) Apply the 9 inch probe to each of the preselected bearing housing positions, holding the probe in position at each housing for about 10 seconds, and then waiting about 10 seconds before applying it to the next position.

This sequential measurement of the bearings while the analyzer is plotting will produce a series of flat topped peaks, since each time the 9 inch probe is removed from a bearing the g-SE level will drop to zero. The flat top of each peak will indicate the SPIKE ENERGY units (g-SE) level of each bearing. Further information on SPIKE ENERGY units analysis techniques is provided in Appendix C.

4.6 OBTAINING TACHOMETER (RPM) PRINTOUT

If the optional tachometer accessory is connected to the Model 820/820M, it will provide a printout of the RPM of the machine within the speed range of 10 to 99,990 RPM. The accuracy of the printout is .05% at 10 RPM. A BROAD spectrum RPM printout is shown in Figure 4-6.

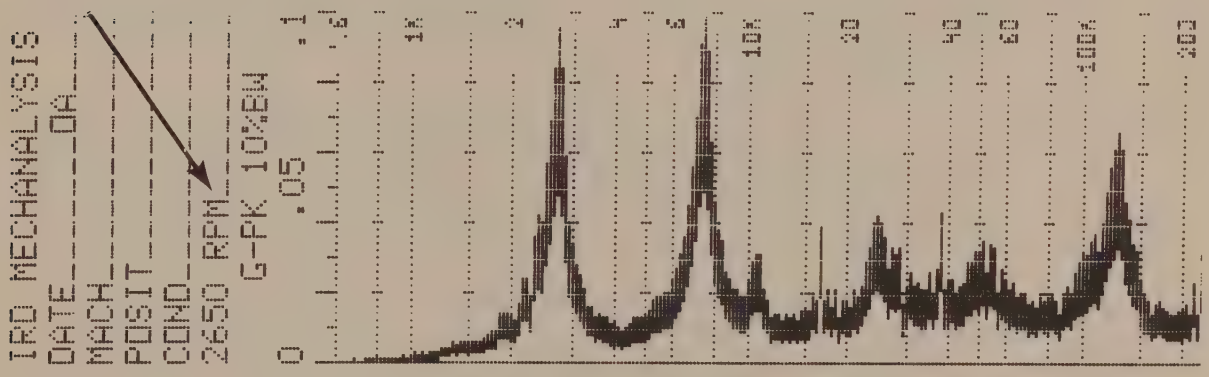


FIGURE 4-6 EXAMPLE OF TACHOMETER PRINTOUT

To obtain a tachometer printout, proceed as follows:

1. Set up the analyzer as described in Chapter III.

2. Select either the photoelectric pickup and cable, or the electromagnetic pickup and its associated cable. For many applications either can be used. The photoelectric pickup has the advantage that it can operate at extended distances from the shaft surface (up to 6 inches), and is effective down to low shaft speeds. The electromagnetic pickup, however, has the advantage of small size and capability to operate for extended periods in dirty industrial environments. In general, the electromagnetic pickup is not recommended for shaft speeds below 600 RPM.

3. Electromagnetic Pickup Setup

If the electromagnetic pickup is to be used, a location on the machine shaft should be selected which contains a sharp edged protrusion or depression (e.g. keyway, hole, or bolt head). Protrusion, or depression, dimensions of 1/4 inch (.64 cm) wide in the direction of rotation and 1/4 inch (.64 cm) height, or depth, will work well, although other dimensions may also give a satisfactory 1 x RPM pulse.

The electromagnetic pickup is then attached to the Universal Mounting Fixture (P/N 5920), or rigid bracket, and adjusted so that the pickup axis is radial to the shaft and the tip of the pickup within about 5 to 20 mils (.13 to .51 mm) of the protrusion or depression.

Photoelectric Pickup Setup

If the photoelectric pickup is used, a small strip of self-adhesive reflective tape (P/N 21200) is attached to the shaft with the tape strip parallel to the shaft centerline. The shaft should be cleaned of oil and dirt to ensure proper adhesion of the tape.

The photoelectric pickup is then attached to the Universal Mounting Fixture (P/N 5920), or rigid bracket, and adjusted so that the pickup axis is radial to the shaft and the tip of the pickup within about 1/2 to 6 inches (1.3 to 15 cm) of the reflective tape.

To check that the photoelectric pickup will provide a satisfactory 1 x RPM pulse, the shaft should be rotated until the reflective tape is directly under the light beam of the photoelectric pickup. At that time the small red LED indicator light should go out. If it does not, move the photoelectric pickup closer to the shaft.

4. Start the machine and bring it up to the speed at which the vibration, or sound, measurements are to be made.

5. Set up the Model 820/820M controls for Spectrum, or Amplitude vs. Time measurements in accordance with the instructions of Sections 4.3 or 4.5.

6. Initiate the plot by momentarily moving the PLOT-ADV/PAUSE switch to the PLOT position. The printer/plotter will commence printing out the plot heading, and then will pause for 6 seconds while sampling the tachometer input. It will then automatically print out the machine RPM, and continue on to plot the spectrum, or amplitude vs. time signals.

With the tachometer connected, each time a plot is initiated the machine RPM will be printed as a part of the plot heading.

V SERVICE

5.1 GENERAL

This chapter consists of the basic trouble shooting and maintenance information for the Model 820/820M Vibration/SPIKE ENERGY Analyzer. Generally, the operational checks, etc., required can be performed by the instrument operator. For com- plete service information, contact your nearest IRD Mechanalysis Customer Service Agency. See the addresses in Section 5.5 of this manual.

5.2 FIELD MAINTENANCE

Field Maintenance of the Model 820/820M instrument and accessories consists of the following operations which do not require the use electronic test equipment:

A. Checking the interconnection cables for proper installation and operation.

B. Replacing the power fuses.

C. Checking the Model 820/820M instrument and accessories for proper setup.

Checking Interconnection Cables

Check the interconnection cables for correct installation (See Chapter III).

Check all plug-in, twist lock, and threaded connectors for proper seating in the receptacles. The threaded connectors should be installed finger-tight.

Move the connector slightly to check for intermittent cables. Replace all worn, damaged, or intermittent cables. See the Part Numbers listed in the Specifications, Appendix A.

Replacing Power Fuses

Two power fuses are located inside the instrument housing, and are accessible from the battery compartment by removal of the compartment cover, and the battery pack. Both fuses are mounted in clip holders, and can be removed for checking or replacement through the access hole inside the battery compartment. The 1-1/2-ampere fuse, Part No. 01508, protects the analyzer circuits from the 6-volt output of the battery pack. The 2-ampere fuse, Part No. 20138, protects the Printer/Plotter circuits from the 12-volt of the battery pack. Do not use a higher amperage fuse as serious damage to the instrument could result. If either fuse blows repeatedly, return the instrument and accessories for service before using.

Checking Preparation and Setup

Instructions for preparing and setting up the Model 820/820M instrument and acces- sories for the standard operations are pre- sented in Chapters III and IV. If satisfac- tory operation is not obtained, review these instructions, and make certain that the analyzer and accessories are prepared and set up correctly.

5.3 ORDERING REPLACEMENT PARTS

To order replacement parts, contact either your local IRD Customer Service Agency, or the IRD Mechanalysis home office, see addresses in Section 5.5. On your Purchase Order, specify the following information:

1. Model and complete Serial Number of instrument.
2. IRD Mechanalysis Part Number.
3. Name of part (capacitor, diode, resistor, etc.).
4. Reference Symbol (C101, D107, R321, etc.).

5.4 OBTAINING SERVICE

Before returning the instrument for repair, obtain service and shipping instructions from either your local IRD Service Agency, or the IRD Mechanalysis home office (See addresses in Section 5.5). Package the instrument, accelerometer, pickup cables, and extension cables inside a strong carton. Each article must be well padded. In addition, information should also be included giving details as to the nature of the problem or the service desired.

5.5 CUSTOMER SERVICE AGENCIES

USA

IRD MECHANALYSIS, INC.
6150 Huntley Road
Columbus, Ohio 43229
Phone: 614/885-5376
Telex: 24:5318

IRD MECHANALYSIS, INC.
8826 Interchange Drive
Houston, Texas 77054
Phone: 713/667-0941

IRD MECHANALYSIS, INC.
1131 Warren Avenue
Downers Grove, Ill. 60515
Phone: 312/960-4065

IRD MECHANALYSIS, INC.
Suite 202
3130 Maple Drive, N.E.
Atlanta, Georgia 30305
Phone: 404/237-4875

IRD MECHANALYSIS, INC.
Suite A2
221 So. Chester Pike
Glenolden, Penn. 19036
Phone: 215/461-7060

IRD MECHANALYSIS, INC.
Suite 4
3377 Mount Diablo Blvd.
Lafayette, Calif. 94549
Phone: 415/283-2065

CANADA

IRD MECHANALYSIS LIMITED
333 Barton Street East
Stoney Creek, (Hamilton)
Ontario, Canada L8E 2L1
Phone: 416/662-7577
Telex: 061-8453
Telex: 851-617034 IRD MECH G

IRD MECHANALYSIS LIMITED
Room 301
524 17 Avenue, S.W.
Calgary, Alberta
Canada T2S 0B2
Phone: 403/264-4130
Telex: 03-824680

UNITED KINGDOM

IRD MECHANALYSIS (UK) LIMITED
Bumpers Lane
Sealand Industrial Estate
Chester, United Kingdom CH1 4LT
Phone: Chester 44/244/374914-5
Chester 44/244/317557-8

WESTERN EUROPE

IRD MECHANALYSIS, S.A.
Avenue Winston Churchill 98
B1180 Brussels, Belgium
Phone: 32/2/344.70.58
32/2/344.72.18
Telex: 846-61256 IRD BRU B

FRANCE

IRD MECHANALYSIS France S.a.r.l.
23a, Rue Brongniart
F92310 Sevres
France
Phone: (1) 534 42 96

AUSTRALIA

IRD MECHANALYSIS (AUSTRALIA)
PTY. LTD.
337 Pacific Highway
Crows Nest, NSW 2065
Australia
Phone: (02) 929 8122
Telex: AA 23193

INDIA

IRD MECHANALYSIS (INDIA) LTD.
47/48 Jolly Maker Chambers II
Nariman Point
Post Office Box 991
Bombay 400 021, India
Phone: 230430
Telex: 953-11-3209 CIPL IN

5.6 UPDATE RECORD

The following table contains a summary of the changes incorporated in the Model 820 at the instrument updatings. The changes listed are keyed to a corresponding Serial Number Prefix Letter which identifies the instrument configuration, or revision level, at the time of manufacture. When a Suffix Letter follows the Serial Number, it identifies the revision level to which the instrument has been updated by the IRD Mechanalysis Service Department or Agency.

In the table below, the reference ECO numbers and the approximate revision dates are included along with the corresponding descriptions of the changes provided. The Prefix Letter listed for the most recent updating is also printed on the face page of this manual. Instrument revisions that are provided after this date are described in a separate addendum.

UPDATE RECORD

PREFIX LETTER	SUMMARY OF REVISION	REVISION DATE	ECO NUMBER
	FIRST PRINTING OF MANUAL - 6/81		
B	Misc. instrument changes (no change in operation)	11/81	5097
C	Enhanced version. Part Numbers changed to following: Signal Conditioner PCB Assm. - P/N 27693, Fuse PCB Assm. - P/N 27700, Mother PCB Assm. - P/N 25355, Micro. PCB Assm. - P/N 27699 Operation changed as follows: lid-actuated power cut-off switch provided, chart paper speeds selected by 3 position toggle switch, vibration input altered to accept Non-contact Pickup connection, plotting initiated from 3 different frequencies using the PLOT/PAUSE switch.	11/82	5561
D	Misc. Hardware changes (no change in operation)	11/82	5896
E	Program change on Micro PCB (no change in operation)	3/84	6631
	SECOND PRINTING OF MANUAL - 8/84		

APPENDIX A

Specifications for:

- Model 820/820M, Vibration/SPIKE ENERGY Analyzer
- Model 970 Accelerometer
- Model 544 Velocity Pickup
- Model 426 Battery Charger

APPENDIX A

SPECIFICATIONS

This section consists of specifications for the Model 820/820M Vibration/SPIKE ENERGY Analyzer, the Model 970 Accelerometer, optional Model 544 Velocity Pickup, and Model 425 Battery Charger.

MODEL 820 and 820M SPECIFICATIONS

FREQUENCY RANGE
- Displacement: 600 to 600,000 CPM
- Velocity: 600 to 600,000 CPM
- Acceleration: 600 to 600,000 CPM
- SPIKE ENERGY Units: Ultrasonic

FILTER RANGE
- 600 to 600,000 CPM

FILTER CHARACTERISTICS
- Broad: Filter bandwidth 10% (Q = 10) at 3dB down
- Sharp: Filter bandwidth 5% (Q = 20) at 3dB down

MEASUREMENT UNITS
- With Model 970 Accelerometer
  - Velocity
  - Acceleration
  - SPIKE ENERGY Units
- With (optional) Model 544 Velocity Transducer
  - Displacement
  - Velocity

DISPLACEMENT RANGE
- English: 0 to 100 mils in eight full-scale overlapping ranges: 0 to .03; 0 to .1; 0 to .3; 0 to 1; 0 to 10; 0 to 30; 0 to 100 mils peak-to-peak
- Metric: 0 to 3000 micrometers in eight full-scale overlapping ranges: 0 to 1; 0 to 3; 0 to 10, 0 to 30; 0 to 100; 0 to 300; 0 to 1000; 0 to 3000 micrometers peak-to-peak

VELOCITY RANGE
- English: 0 to 100 inches/sec in eight full-scale overlapping ranges: 0 to .03; 0 to .1; 0 to .3; 0 to 1; 0 to 3; 0 to 10; 0 to 30; 0 to 100 inches/sec peak
- Metric: 0 to 3000 millimeters/sec in eight full-scale over- lapping ranges: 0 to 1; 0 to 3; 0 to 10; 0 to 30; 0 to 100; 0 to 300; 0 to 1000; 0 to 3000 millimeters/sec peak

ACCELERATION RANGE

- English and Metric: 0 to 100 g's in eight full-scale over- lapping ranges: 0 to .03; 0 to .1; 0 to .3; 0 to 1; 0 to 3; 0 to 10; 0 to 30; 0 to 100 g peak (lg = 386 inches/sec^2, or 980 cm/sec^2).

SE (SPIKE ENERGY) Units

- English and Metric; 0 to 100 g's SE in eight full-scale over-lapping ranges: 0 to .03; 0 to .1; 0 to .3; 0 to 1; 0 to 3; 0 to 10; 0 to 30; 0 to 100 g's SE with special circuits designed to detect SPIKE ENERGY (SE) vibrations.

TACHOMETER RANGE

- 10 to 99,990 RPM

TEST SIGNAL

- Internally generated square wave test signal, tests all circuits.

BATTERY TEST

- All batteries tested under load; battery condition shown on meter with "HI" and "LO" positions marked on meter scale.

INPUTS

- One vibration/acoustic signal input channel with quick-connect receptacle
- One battery charger/tachometer input channel
- Accepts vibration input from Model 970 Accelerometer
- Accepts vibration input from Model 544 Velocity Transducer
- Accepts acoustic input from Model 308 Vibration/Sound Level Meter

READOUT

- Panel meter displays overall (Filter Out) vibration, or acoustic, level.

PRINTOUT

- Alphanumeric and Graphic Printout including grid and scale on 2-1/4 inch (5.7 cm) wide thermal paper
- Spectrum Analysis
- Broad: (10% BW); 600 to 600,000 CPM; plot time - 36 sec.
- Sharp: (5% BW); 600 to 600,000 CPM; plot time - 93 sec.
- Overall (Filter Out) Amplitude (level) vs. Time
- Plot terminated manually by operator.

- Chart Paper speed, switch selectable:

Mode	Paper Speed	Points Plotted/sec
Slow	.65 in. (1.7 cm) per min.	0.5
Medium	3.25 in. (8.3 cm) per min.	2.5
Fast	13 in. (33 cm) per min.	10.0

- Chart Paper: One 90 ft. (27.4 m) chart roll provides approximately 90 broad, or 60 sharp, spectra

TEMPERATURE RANGE
- Storage: -40°F to +140°F (-40°C to +60°C)
- Battery Operation: +5°F to +140°F (-15°C to +60°C)
- Charging: +5°F to +122°F (-15°C to +50°C)

RELATIVE HUMIDITY
- 0 to 95% at +104°F (+40°C) Non-Condensing

PACKAGING
- Aluminum case with shoulder strap
- Easy access battery compartment for quick change of battery pack.

DIMENSIONS
- Instrument Case: 8-3/8" x 11-1/4" x 8-3/4" (21.3 x 28.6 x 22.2 cm)
- Instrument Case with storage cover: 8-3/8" x 11-1/4" x 10-3/4" (21.3 x 28.6 x 27.3 cm)

WEIGHT
- Instrument: 16.5 pounds (7.4 Kg)
- Instrument with storage cover and accessories: 20.3 pounds (9.1 Kg)

POWER REQUIREMENTS
- Battery Power: Built-in, quick replaceable sealed rechargeable battery pack; 10 hours operation per full battery charge (equivalent to approximately 700 broad, or 300 sharp, spectra)
- Battery Charge; Provided by battery charger whenever connected to Model 820, or extra battery pack, with circuit to prevent overcharge. Charger operates on 50 or 60 Hz, 120 or 240 Volts AC.

STANDARD ACCESSORIES

1--Model 970 Accelerometer, P/N 19697
1--12 ft. (3.7 m) Pickup Cable for Model 970 Accelerometer, P/N 20431
1--9 inch (23 cm) probe, P/N 1103
1--Battery Charger, Model 426, P/N 28560, including Power Cable and Charger Output cable
6--Rolls Chart Paper (90 ft., 27.4 m) per roll, P/N 24444
1--Instruction Manual

OPTIONAL ACCESSORIES

- Extra Battery Pack, P/N 24400
- Extra Battery Pack Charger Adapter, P/N 24458
- Model 544 Velocity Transducer, P/N 4526
- 12 Ft. (3.7 m) Pickup Cable for Model 544 Transducer, P/N 20433
- 25 ft. (7.6 m) Extension Cable for Model 544 Transducer, P/N 21045
- 50 ft. (15.2 m) Extension Cable for Model 544 Transducer, P/N 21049
- Magnetic Holder for Model 970 Accelerometer, P/N 24746
- Magnetic Holder for Model 544 Transducer, P/N 4332
- 25 ft. (7.6 m) Extension Cable for Model 970 Accelerometer, P/N 21044
- 50 ft. (15.2 m) Extension Cable for Model 970 Accelerometer, P/N 21048
- Model 308 Vibration/Sound Level Meter
- One lot (48 rolls per lot) of chart paper; sold only by lot, P/N 24444
- 25 ft. (7.6 m) Photoelectric Tachometer Signal Cable, P/N 24761
- Photoelectric Reference (Tachometer) Pickup, P/N 21000
- Roll (150 ft. (46 m) of 1/4 inch (1 cm) reflective tape; required for operation of Photoelectric Pickup, P/N 21200
- 25 ft. (7.6 m) Electromagnetic Tachometer Signal Cable, P/N 24762
- Electromagnetic Reference (Tachometer) Pickup, P/N 5106
- Universal Mounting Fixture for Photoelectric or Electromagnetic Pickup, P/N 5920
- Calibrator, P/N 21073
- Vibration Chart Storage Notebook with 50 filler sheets, P/N 25864
- Pack of 100 Extra Notebook Filler Sheets, P/N 25865

MODEL 970 ACCELEROMETER SPECIFICATIONS

ITEM	SPECIFICATION
RESONANT FREQ.	27,000 Hz, or higher.
FREQUENCY RANGE	180 g's, peak, up to 1K Hz; 120 g's, peak, at 5K Hz; or 70 g's, peak, at 10K Hz (with ±15 VDC supply and 25-foot input cable having a capacitance of 50 pf per foot.
NOTE: If a longer cable is used, the maximum amplitude and/or high-frequency response will be reduced. Also, if a lower voltage supply is used, the maximum amplitude will be reduced proportionally.	
SENSITIVITY	50 millivolts per g (nominal).
TEMPERATURE RANGE	From -40 to +250°F (-40 to +121°C).
ORIENTATION	Any position.
TRANSVERSE RESPONSE	5 percent, maximum, 3 percent typical.
MAGNETIC FIELD SENSITIVITY	Less than 0.0001 g per gauss at 60 Hz.
RESIDUAL NOISE	Less than 0.0002 g.
SUPPLY VOLTAGE	Regulated +8 volts, ±1.2 mA, maximum, to ±15 VDC at ±1.75 mA, maximum.
HOUSING	Waterproof and dustproof, Series 300 stainless steel, welded case.
SIGNAL CABLE	4-pin, threaded receptacle, Type 12S-10P.
GROUNDING	Case isolated from signal ground (insulated mount required if the rotating machine is significantly above ground potential).
AMPLITUDE	1000 g's, peak, of sinusoidal vibration, or 2000 g's, peak, with a 10-millisecond half-sine, with no damage to the accelerometer.
MOUNTING	Threaded mounting hole, 1/4-28 x 1/4 inch, at flat end of accelerometer.
WEIGHT	7.7 ounces (200 grams).

MODEL 544 VELOCITY PICKUP SPECIFICATIONS

ITEM	SPECIFICATIONS
FREQUENCY RANGE	720 to 60,000 CPM (12 to 1000 Hz) at ±8%, -8 to +13% at 600 CPM (10 Hz).
SENSITIVITY	764 ±10% mV, rms, per in/sec, peak.
TEMP. RANGE	-40 to +500° F (-40 to +260° C).
IMPEDANCE	Resistance 2000 Ohms; Inductance, 0.7 Henry.
DAMPING FACTOR	0.7 at critical frequency.
ORIENTATION	Any position
TRANSVERSE RESPONSE	Less than 5%, average, from 600 to 60,000 CPM (10 to 1000 Hz).
MAGNETIC FIELD SENSITIVITY	0.15 inch/second/gauss.
HOUSING	Weatherproof and dustproof.
SIGNAL CABLE	2-pin, threaded receptacle, No. 732S-10SL-4P.
WEIGHT	21 ounces, (0.06 kgm).
GROUNDING	Case and signal ground, common.
MOUNTING	Threaded mounting hole, 1/4-28 x 1/4 inch, at flat end of the pickup.
AMPLITUDE	125 mils (3175 micrometers) maximum, (up to 700 Hz, 30 g's above 70 Hz).

MODEL 426 BATTERY CHARGER SPECIFICATIONS

ITEM	SPECIFICATIONS
Power Requirement:	120 VAC ±10%, 50/60 Hz 220 VAC ±10%, 50/60 Hz
NOTE: The voltage selector slide switch on the underside of the Battery Charger is set to the left-hand position for 120 VAC input power, and to the right-hand position for 240 VAC input power.	
Voltage Outputs:	13.5 VDC @ 250 mA 6.85 VDC @ 300 mA
Cables (2):	
AC Power:	Two-wire 120 VAC or 240 VAC ±10%, @ 50/60 Hz (slide switch set to position corresponding to the AC voltage to be used).
Charger Output:	To Charger Input Receptacle of Model 816 or 820 instrument.

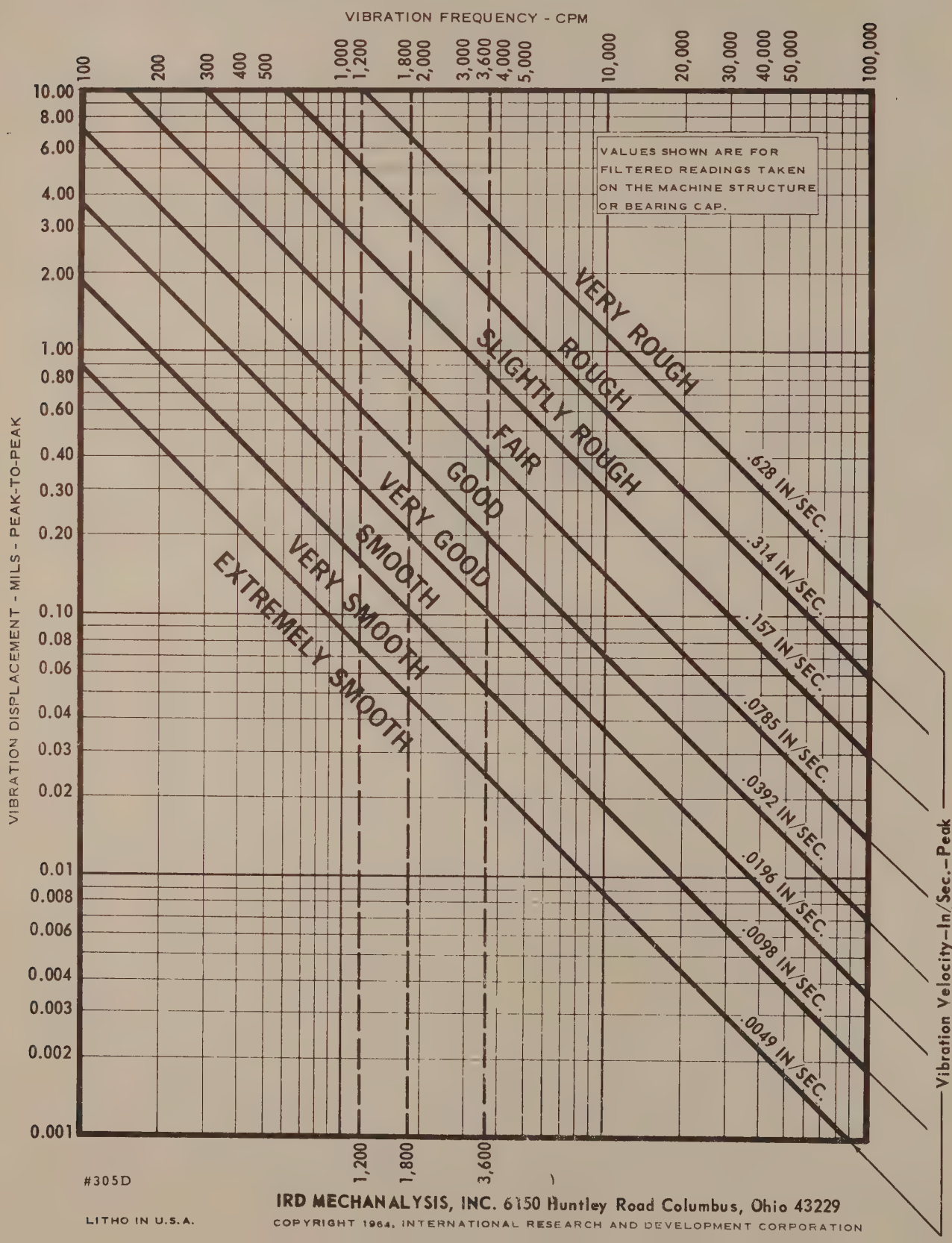
APPENDIX B

Guideline

Vibration Severity Charts

GENERAL MACHINERY
VIBRATION SEVERITY CHART

For use as a GUIDE in judging vibration as a warning of impending trouble.



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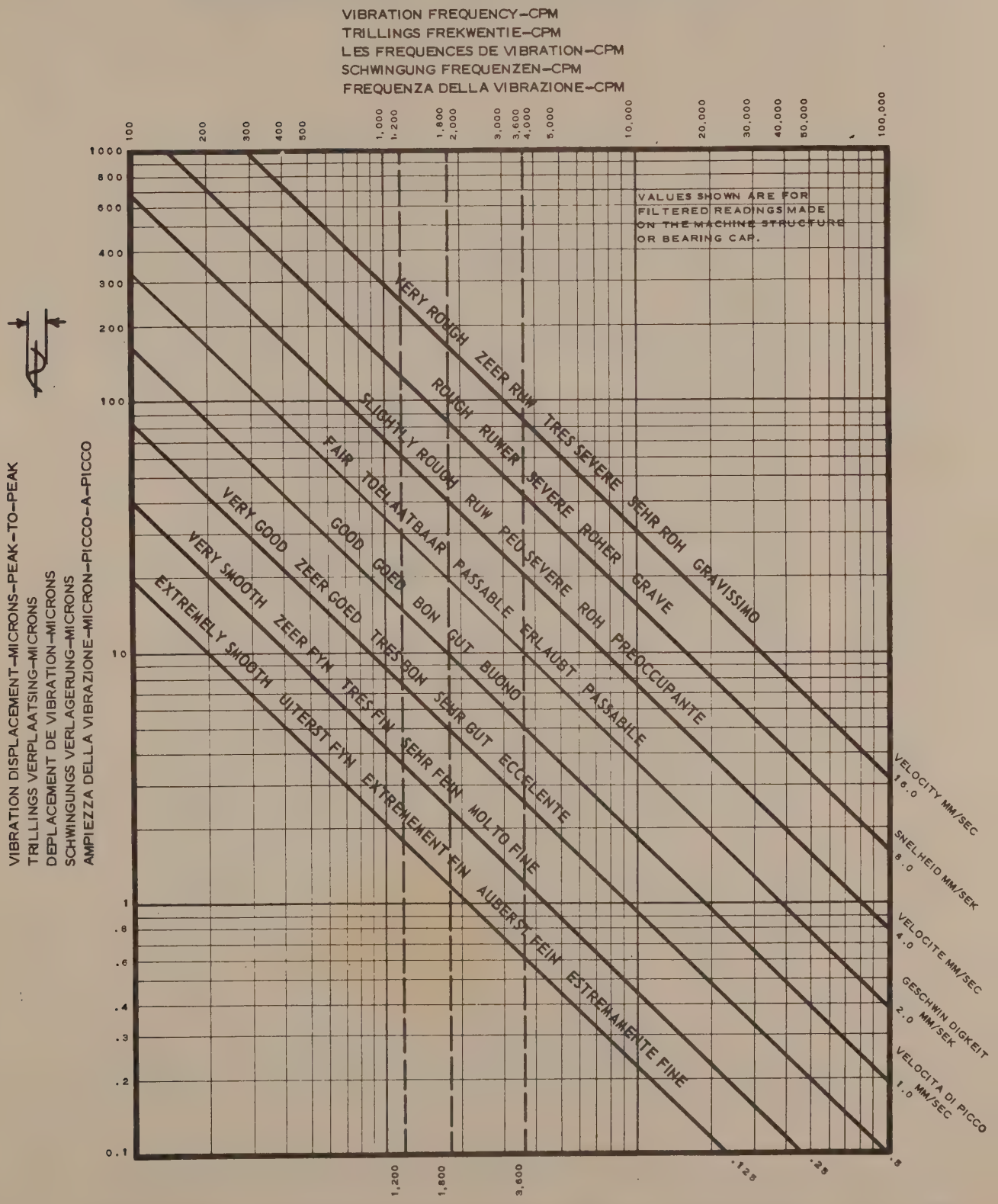
GENERAL MACHINERY VIBRATION SEVERITY CHART
TRILLINGS STRENGHEIDSKAART VOOR ALGEMENE MACHINES
TABLEAU DE SEVERITE VIBRATOIRE POUR LES MACHINES EN GENERAL
SCHWINGUNGSSTRENGE TABELLE FUR ALLGEMEINE MASCHINEN
NOMOGRAMMA GENERALE DI PERICOLOSITA DELLA VIBRAZIONE



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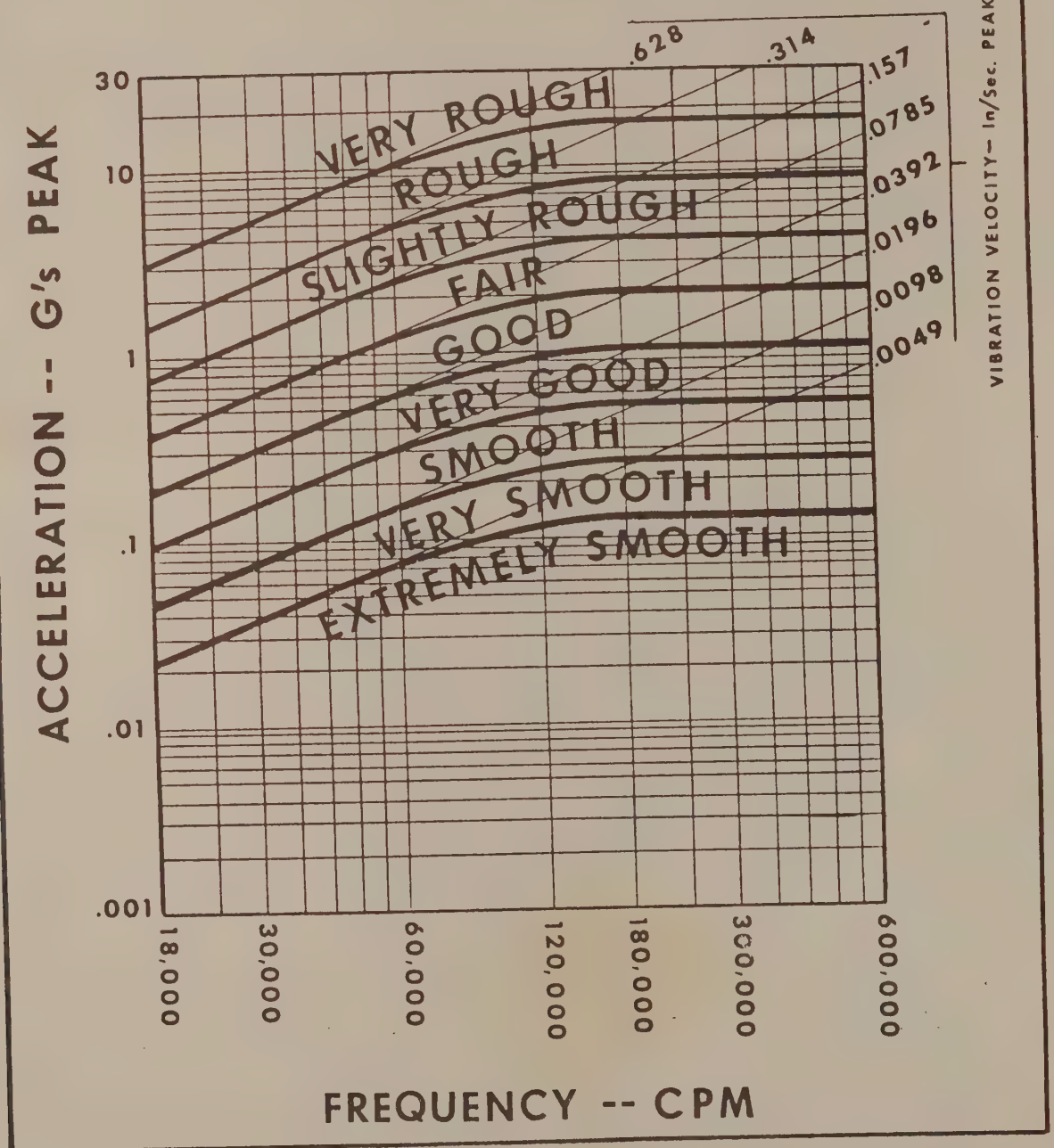
VIBRATION ACCELERATION
GENERAL SEVERITY CHART



APPENDIX C

Use of SPIKE ENERGY Analysis to Detect Defects in Rolling Element Bearings and Gears

USE OF SPIKE ENERGY SIGNAL ANALYSIS TO DETECT DEFECTS IN ROLLING ELEMENT BEARINGS AND GEARS

SPIKE ENERGY CIRCUITS

The SPIKE ENERGY detection circuits are designed to sense the amplitude of the microsecond range pulses caused by impacts between bearing elements which have microscopic flaws. In addition to detecting pulse amplitude, these circuits also detect the rate of occurrence of the pulses and the amplitude of the high frequency random broad band vibratory energy associated with bearing defects. These three parameters of pulse amplitude, pulse rate and high frequency random vibratory energy are electronically combined into a single quantity called "g-SE" which is a measure of bearing condition. The term "g-SE" (i.e., SPIKE ENERGY acceleration units) has been selected to indicate that this type of measurement is more comprehensive than g-peak and g-RMS measurements.

ESTABLISHING A BEARING DEFECT DETECTION PROGRAM

To establish a program for checking the condition of rolling element bearings, a "comparison" method can be used. That is, the g-SE levels of similar machines are measured and any levels which significantly depart from the average are singled out for further analysis, and closer watch, as potential bearing problems. This method rapidly leads to establishment of criteria levels which distinguish good and bad bearings. It should be noted that the g-SE levels depend on the machine rotational speed (RPM), and typically double for each doubling of RPM. From a vibration severity standpoint, however, it should be kept in mind that low speed bearings can usually tolerate more damage than high speed bearings, since low speed bearings tend to deteriorate more slowly than high speed types.

The use of "trending" is another way of detecting defective bearings. In this method, the machine bearings are measured periodically and their g-SE levels recorded. No change in the level over a period of time indicates a good bearing, while a significant upward trend indicates a deteriorating bearing.

As an additional aid in establishing g-SE level criteria for good and bad bearings, general experience indicates that when making bearing checks of machines in the 600 to 3600 RPM range with the 9-inch probe, a g-SE level of 0.5 or greater is often an indicator of a defective bearing. This number should, of course, be used with caution since many factors can affect the level measured, such as bearing type, machine type, etc. It should also be noted that where greater sensitivity to bearing defects is desired, the transducer can be flush mounted (i.e., without the 9-inch probe) to the bearing housing. In all cases the probe, or transducer, should contact the bearing housing with a light, steady pressure in such a manner that no chatter occurs.

GEAR DEFECTS

A program to detect incipient gear defects can be established in the same manner as that described above for rolling element bearings.

OTHER SOURCES OF SPIKE ENERGY SIGNALS

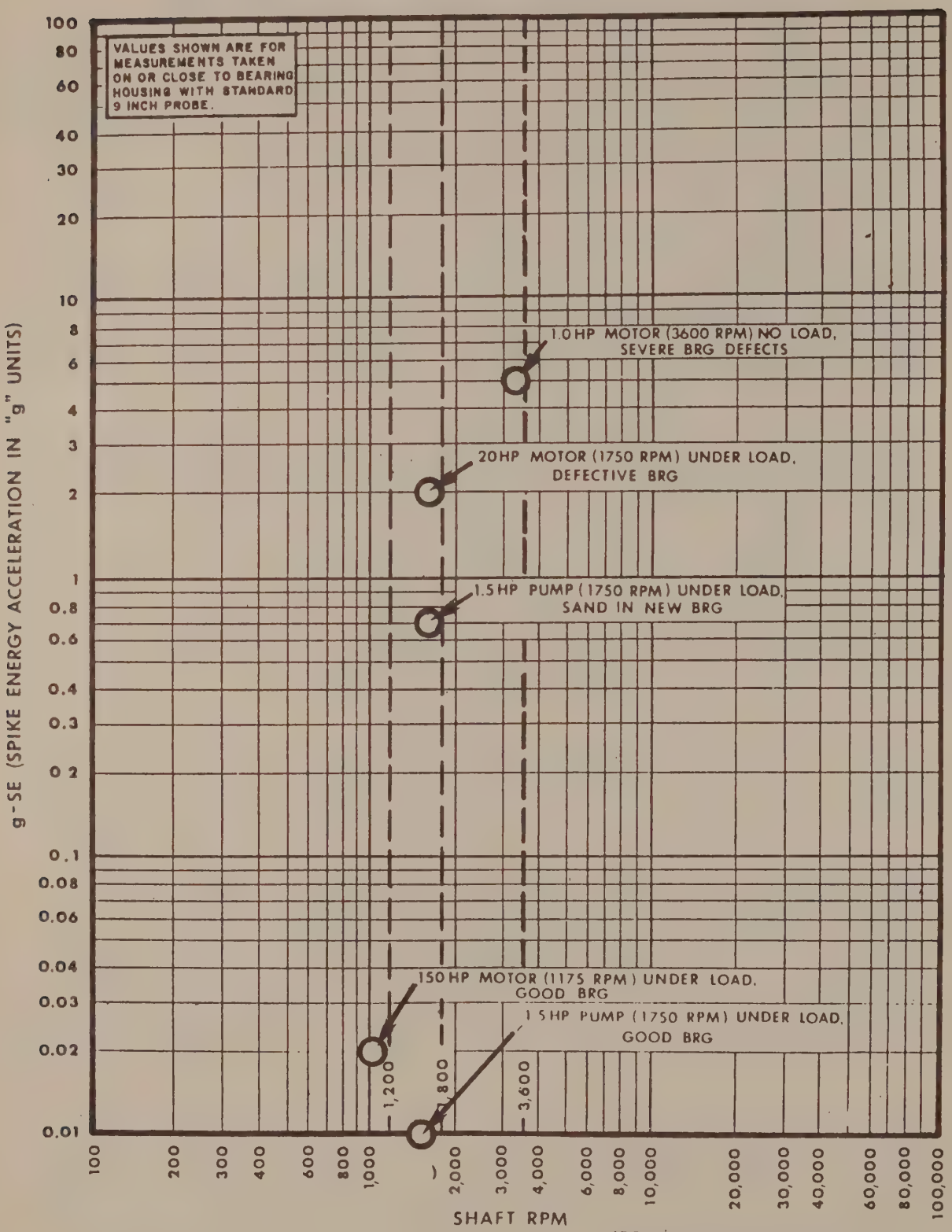
When taking bearing checks, it must be kept in mind that there are sources other than bearings which give off spike energy. Gears, cavitation, rubbing or striking of metal parts such as seals and coupling guards, are some of the more common sources which are likely to be encountered. These sources, if close to the bearing frequencies being measured, should be checked to avoid possible misinterpretation of the data.

ROLLING ELEMENT BEARING g-SE SEVERITY CHART

A "Rolling Element Bearing g-SE Severity Chart" is shown in the accompanying chart. This chart can be used as an aid in establishing g-SE severity criteria. No specific severity levels such as "smooth", "good", etc., have been assigned, since there are too many variables (bearing types, machine types, speed, loads, etc.) which can affect the levels measured. Some case histories, however, are plotted on the chart to provide an indication of the type of results which can be obtained.

By plotting the g-SE levels of the machines to be included with-in a bearing check program on a chart, severity criteria can be readily developed which are tailored to the individual machines involved. These charts are available from IRD MECHANALYSIS on Form No. 1925 (P/N 22756).

ROLLING ELEMENT BEARING g-SE SEVERITY CHART



FORM 1925/ITEM NO 22756

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APPENDIX D

Calculation Procedure for Increased Accuracy of Individual Frequency Peaks

APPENDIX D

CALCULATION PROCEDURE FOR INCREASED FREQUENCY ACCURACY OF INDIVIDUAL FREQUENCY PEAKS

In the BROAD and SHARP modes, the spectrum printout separates out the individual vibration components so that individual peak amplitudes and frequencies can be determined. A single frequency signal is identified by the characteristic "peak" reading on the printout where the highest amplitude line at the center of the peak is a measure of the magnitude of that component and the location of that line along the frequency scale is used to determine frequency.

The frequency of a typical signal peak can be determined with accuracy if the line position along the frequency scale can be accurately located. With care, accuracy of close to ±1-1/2 percent is possible in SHARP, and ±2-1/2 percent in BROAD. To do this, first locate the nearest frequency (vertical) graticule line in the plot below the peak and identify the frequency of that line by reference to the frequencies printed along the top edge of the plot. Next count the number of "frequency lines" from that graticule line to the peak line of the signal to be identified. The frequency of a peak may be approximately centered between two "frequency lines" in a peak. In this case, there will be two lines printed at the top of the peak which have about the same amplitude. Refer to the Frequency Calculation Table below for the frequency multiplier factor. Multiply the frequency of the graticule line by this miltiplier to get the frequency of the peak. If there are two peak lines of equal amplitude, calculate the frequency of each by the above method and then find the mid-frequency between them.

Example: A peak has a single predominant line printed at the center of a peak which is 4 lines above the graticule line 12,000 CPM in the SHARP mode. From the table for SHARP, the multiplier is 1.066 for 4 lines. 1.066 x 12,000 = 12,790 CPM ±1-1/2 percent. (See Figure D-1).

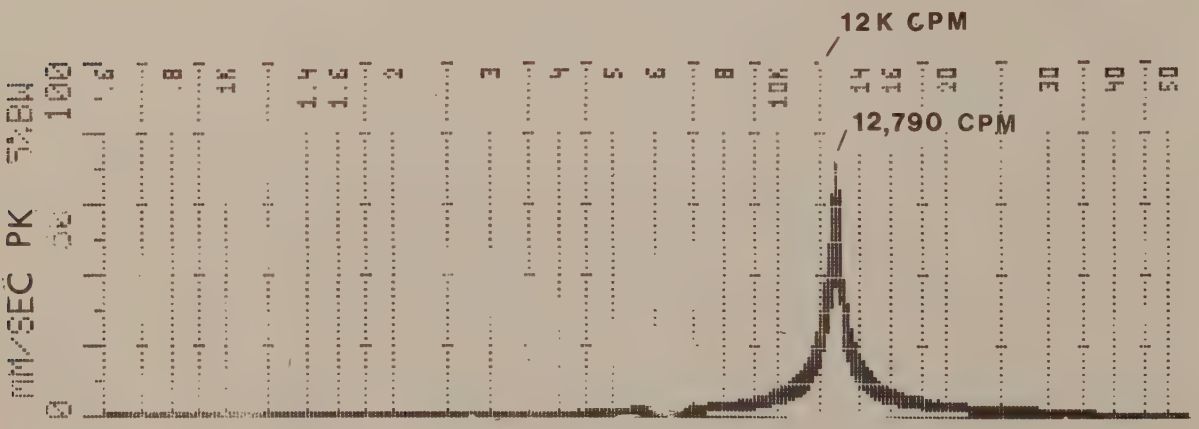

Figure D-1 Example of Procedure for Calculating the Frequency of a Peak

When the printout contains a series of lines that do not indicate a typical "peak" response shape, it may be due to a vibration component which is unsteady in either frequency or amplitude or both, or it may indicate random vibration.

FREQUENCY CALCULATION TABLE

Number of Lines Above Frequency Graticule	SHARP Frequency Multiply Factor	BROAD Frequency Multiply Factor
1	1.016	1.026
2	1.033	1.054
3	1.049	1.082
4	1.066	1.11
5	1.084	1.14
6	1.101	1.17
7	1.119	1.20
8	1.137	1.233
9	1.156	1.266
10	1.174	1.30
11	1.193	1.333
12	1.213	1.369
13	1.232	1.405
14	1.252	1.442
15	1.272	1.481

ADDENDUM A
Low Frequency Capability
Models 820LF and 820M-LF
November 1, 1984

The Model 820LF and 820M-LF instruments are identified by the letters LF, which are included as a suffix to the instrument Model Number. The Low Frequency capability provided enables these instruments to be used for mechanical analysis and predictive maintenance of machinery having vibration frequency components as low as 180 CPM (3 Hz). The Low Frequency software used provides plotting of the entire frequency spectrum (i.e., from 180 to 600,000 CPM) unless the operator advances the starting frequency or terminates the plot by operating the PLOT ADV/PAUSE switch on the instrument front panel.

The performance specifications of the Model 820LF and 820M-LF instruments differ from those listed in Appendix A of this manual as noted below:

PERFORMANCE SPECIFICATIONS

FREQUENCY RANGE

- Displacement: 180 to 600,000 CPM
- Velocity: 180 to 600,000 CPM
- Acceleration: 180 to 600,000 CPM
- SPIKE ENERGY Units: Ultrasonic

FILTER RANGE

- 180 to 600,000 CPM

PRINTOUT

- Alpha-numeric and Graphic printout including grid and scale on 2-1/4 inch (5.7 cm) with the thermal paper

- Spectrum Analysis:
  - Broad (10% BW): 180 to 600,000 CPM; plot time - 83 seconds
  - Sharp (5% BW): 180 to 600,000 CPM; plot time - 263 seconds
  - Overall (Filter Out): Amplitude Level vs. Time

- Plot terminated manually by operator.